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(Continued on next page)

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POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 142 NO. 3

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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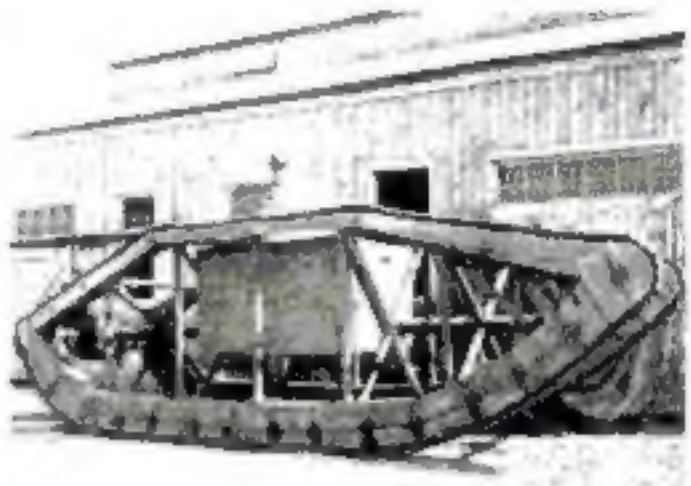

U. S. TANK? Yes, indeed! This mechanical monstrosity is one of the ancestors of the M-3's and M-4's that are now knocking the daylights out of Hitler's vaunted Panzer divisions. Appropriately called "The Skeleton," it was one of many experimental models built by our Ordnance experts near the end of the first World War. Freakish as it looks today, it marks a stage in the patient development work that has given us the best tanks in the world. See page 120.

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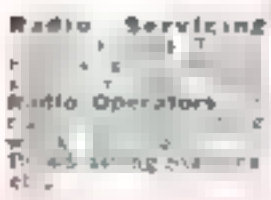

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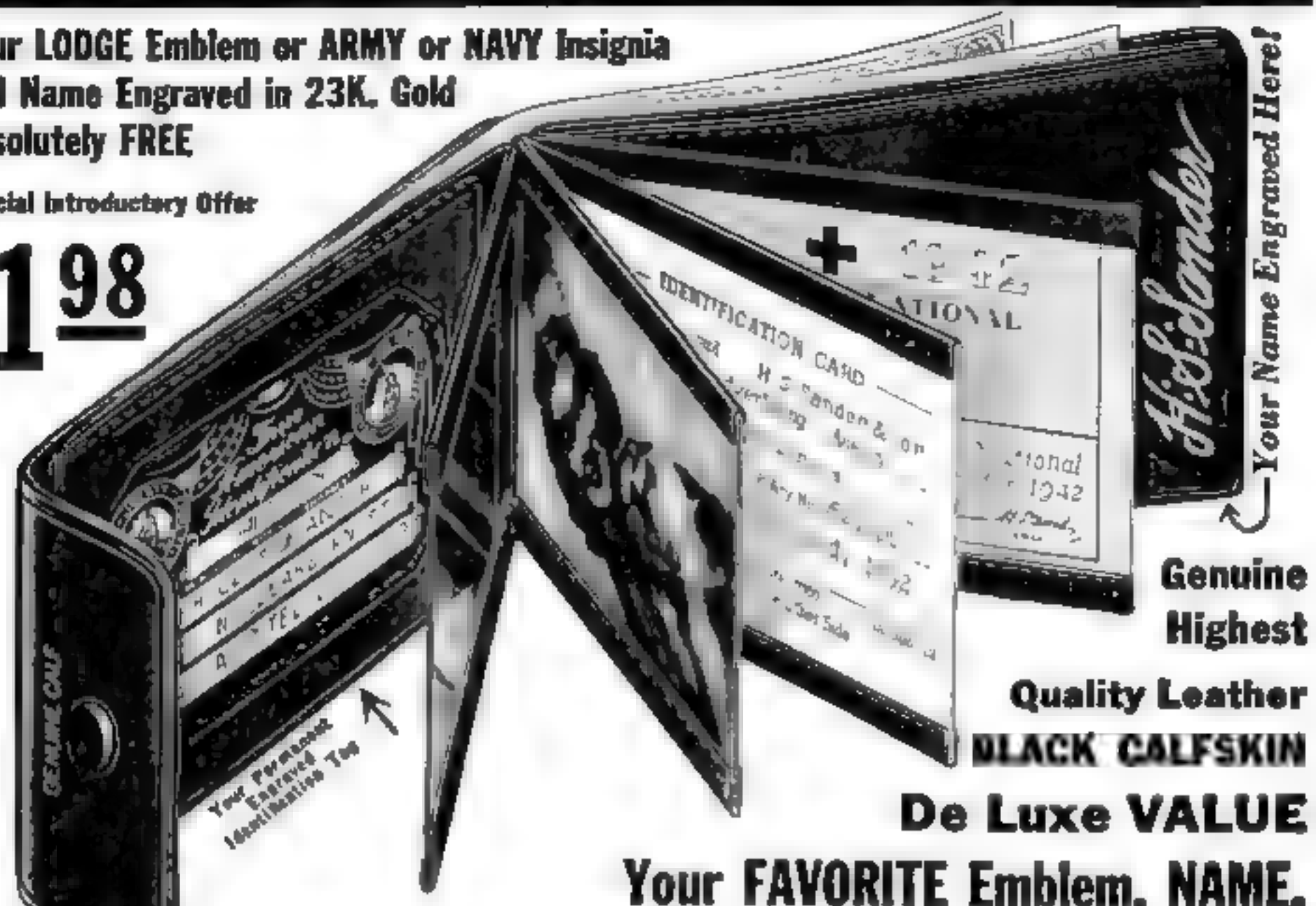

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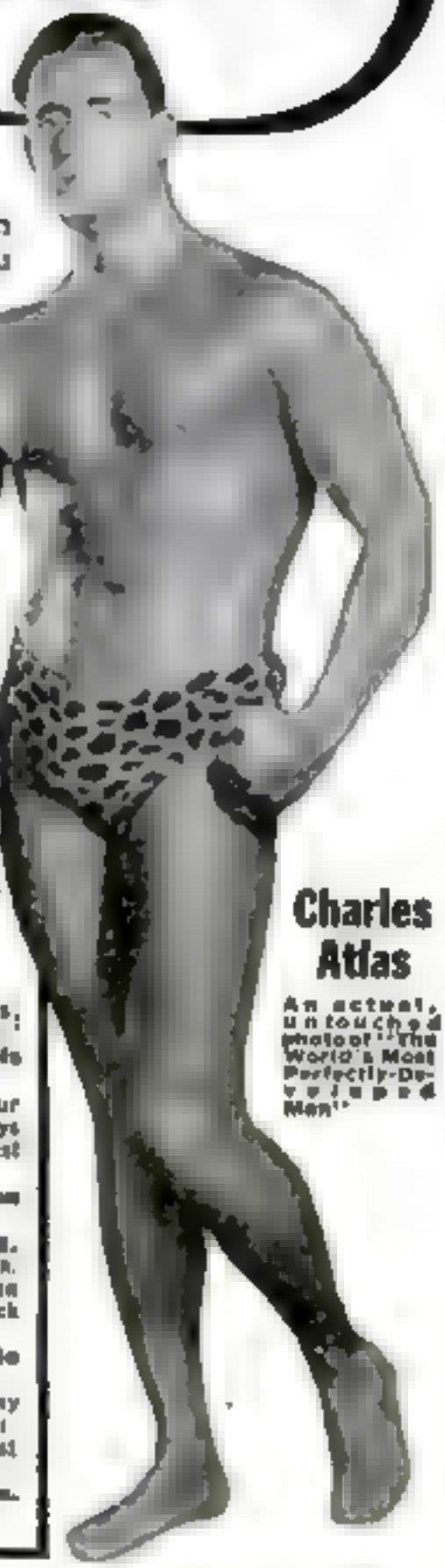

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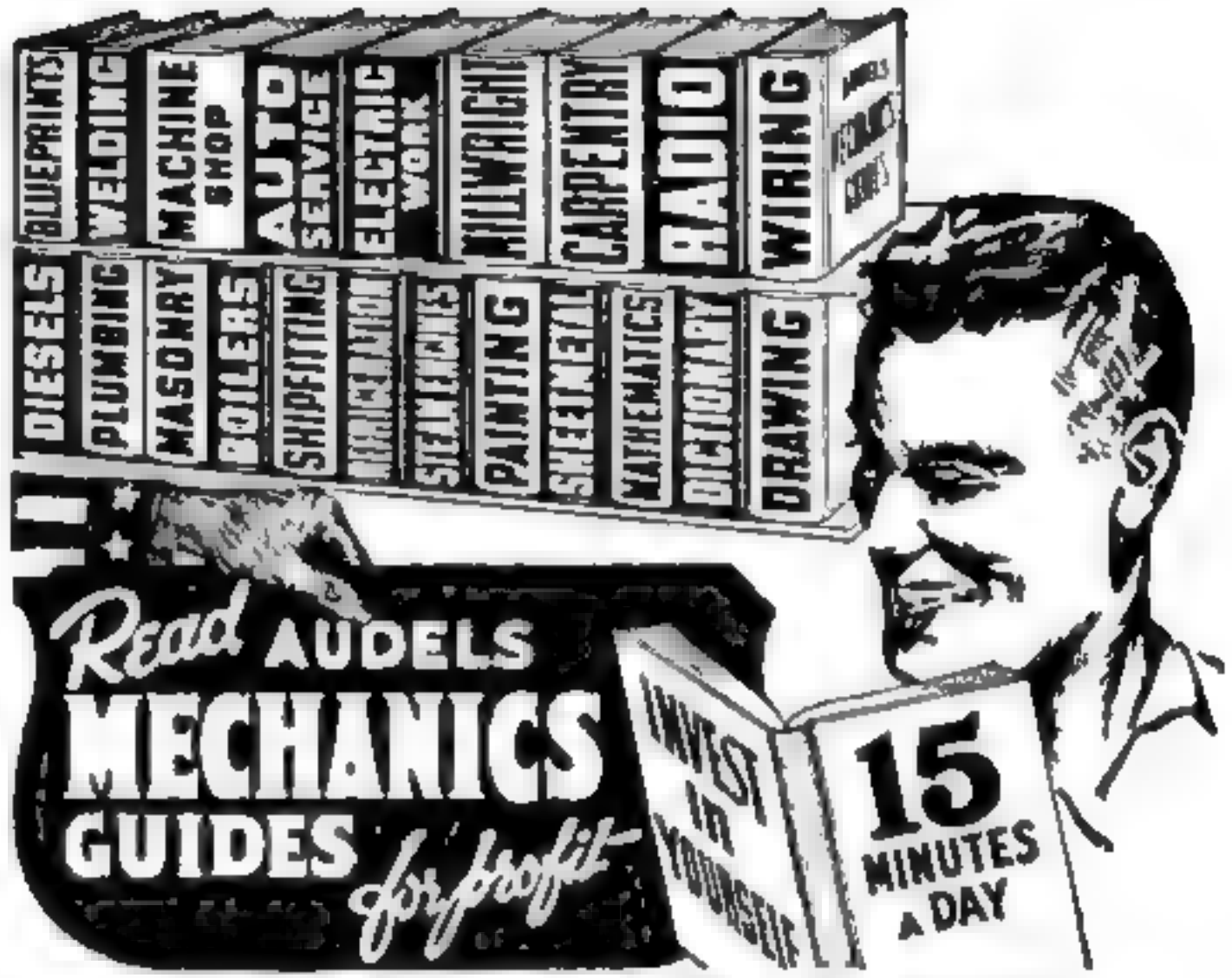

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Coming Next Month

WELDING IS A WAR BABY that came along just in time to carry a big share of the arms-production load. Maybe you know all about welding already. If not, you'll be interested in an article that explains how the man (or woman) in the mask is putting new strength into our snews of war.

AMERICAN BOYS just out of flying school are meeting the seasoned pilots of the Axis air forces and knocking them out of the sky. What makes our relatively inexperienced flyers a match for their battle-hardened adversaries? You'll understand after you read about the rigorous training that prepares our airmen to enter the arena of aerial warfare.

BE A BOMBARDIER! Even if you can't actually ride the nose of a B-17, you can get some of the thrill by playing the "Bombsight" game. You build your own bomber—a miniature plane with a real bombsight that shows you when to release your "eggs" to score a "considered sunk" on a model Jap warship.

SHARPSHOOTERS OF THE SKY are the men who man the machine guns of our warplanes. Americans are good shots by tradition, and our boys have proved apt pupils in the highly specialized art of winging enemy planes from a skyrocketing turret or gun position. Follow them through the training course that gives them their deadly skill.

AFTER YOU HAVE READ "First Steps in Electronics," on page HW 50 in this issue, you'll be ready and anxious to read the second article of this informative series. The April installment will describe the application of electronics to radio, explaining how electrons are harnessed to create the magic of modern communication and entertainment.

TAKE CARE OF YOUR CLOTHES! It's going to get harder and harder to buy new ones. In order to get maximum mileage out of the garments you have, you must give them proper care. Timely repairs and alterations, too, will add months of wear. An article filled with practical suggestions helps you take that stitch in time.

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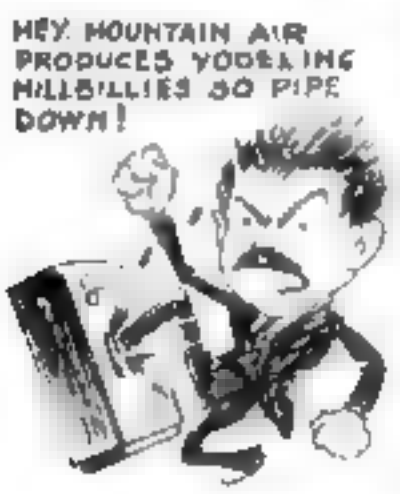
Readers Say:

Two "Pipe Up" on Air Piped Down

HAVE just finished reading in your January issue the idea that A. H. W. of Phoenix, Ariz., dreamed up for using light Pikes Peak air to fill balloons and dirigibles. It reminds me of a fellow up here who, in order to spare himself the expense of the antifreeze he needed for the cooling system of his car, rowed several miles out into Lake Michigan to get some of "that blue water that never freezes."—T. E. W., Manitowoc, Wis.



A. H. W.'s notion of piping Pikes Peak air down the side of the mountain for use in dirigibles is impractical. But it does give me an idea. Why not run a lot of pipe lines down into our cities and smoky industrial centers and let the hard-working people there enjoy the benefits of the healthful and invigorating mountain air? For many years I have been a reader of your magazine which has supplied me with much interesting information, the value of which far exceeds the cost of the magazine.—E. G., Brooklyn, N. Y.

One Thing We Won't Stand For Is a Slipshod Answer

REPLYING to R. P. S. of Bakersfield, California, here is the answer to his bouncing-ball problem. He states that the ball was dropped from a height of 16 feet, rebounded half that distance, and continued to rebound half the distance of each preceding drop. Treating the problem as a purely theoretical case, the ball would travel a total of 48 feet. In an actual experiment the ball would cease to rebound after only 12 or 14 bounces, or when the distance of rebound and the compression of the ball against the ground became approximately equal. The actual calculations for this experiment indicate that on the twentieth bounce, the ball would rise .0000152587890625 of a foot from the ground. If the original drop of the exact center of the ball was precisely 16 feet, then in 20 rebounds the ball would travel 47.999969482421875 feet. —G. K. C., Ganado, Ariz.

They're Working For the Old Man With the Beard

IN "READERS SAY" of your December issue I found a letter from T. F. of Beaver Dam, Wisconsin, who owns a garage with his brother. He asks for suggestions on how they can increase their income now that the war has left them only an occasional job of repair work to do. Here is the answer. The U. S. Civil Service is employing plenty of garage men and mechanics as inspectors of motor vehicles. The base pay is $2,000 a year. In the plant where I work are nearly 80 former garage men who have closed their shops, and are now working for Uncle Sam for the duration.—H. O. W., Detroit, Mich.

P.S.M. Herewith Takes Another Modest Bow

AS PRESIDENT of the New Jersey Mineralogical Society I am happy to tell you that I think your magazine is deserving of a lot of commendation for its excellence. I have been a reader of the magazine for many years and have often felt you should be advised that it makes the best scientific presentations of them all. I am particularly pleased to see that you always have a fine article on minerals, and that it is presented in such a simple, accurate and interesting manner. This has been mentioned particularly by many members of our society. Again, congratulations, and may you continue your fine work. —Joseph D'Agostino, Plainfield, N. J

A Beef That We Haven't Got Enough Meat in Our Problems

THIS MAGAZINE continues to be swell, but my beef is directed at the readers who contribute to this department. What's happened to the fine series of problems that they were turning in a few months back —particularly those that are of real value to a workshop nut who needs that kind of wit sharpening to improve his layout and design technique? Let's have some more that are really worthwhile—G. L., Denver, Col.

This is the way to win a battle in the desert

Libya and North Africa made it clearer than ever: THIS IS A WAR OF SUPPLY.

In 1918, an American soldier could be equipped and maintained on 5 tons of supplies each year.

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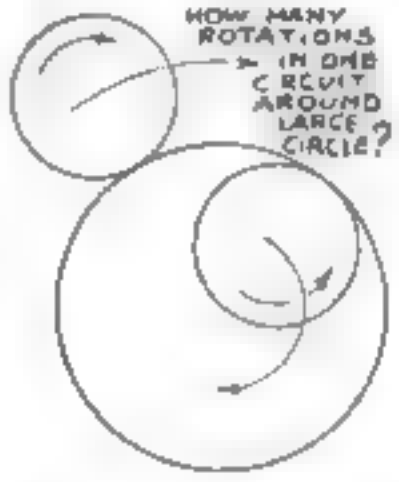
Readers Say:

This Puzzler Will Have You Going 'Round in Circles

HERE is one of my favorite problems which I think some of your readers might be interested in trying to figure out. You start with two circles, the radius of one being exactly twice that of the other. Now if you place the two circles together as shown in diagram at left and roll the smaller circle around the outer circumference of the larger circle, how many rotations on its own axis will the smaller circle make in completing one full trip. Now if you place the smaller circle inside the larger, and roll it around the inner circumference until it completes one full trip, how many rotations on its own axis will it make this time? I'm only 16 years old—but I don't think your readers are going to find this problem too easy. Incidentally, A. W. H. of Phoenix, Ariz., certainly appears to have forgotten his physics or he would remember that a balloon filled with thin high-altitude air would very quick collapse when it was brought down to sea level. —E. A. B., Floral Park, N. Y.



We're Happy To Give Credit Where Credit is Due

ON PAGE 99 of your December issue, you carried a short article on the Bantam B-24 Bomber, a dummy plane only one-third actual size, yet complete in every detail except for engines. You stated that this plane is being manufactured in the Douglas Aircraft Company's training school at Tulsa, Oklahoma, for the purpose of instructing workers in the manufacture and repair of airplanes. May I therefore advise you that this training program has been instituted not by the Douglas Company but by the Tulsa Public Schools Vocational Educational Department. The training, however, is being conducted to meet the standards of the Douglas Aircraft Company —R. B. McHenry, Director of Industrial and Adult Education, Tulsa, Okla.

INVENTORS

NOW Is the Time to PATENT and SELL Your Invention

Now, more than ever before, is the right time to patent your invention. Why? Because manufacturers everywhere presently engaged in war production are looking ahead to the future by buying up patent rights now, so they will have new and attractive items to make and sell for civilian consumption as soon as the war is over. This is what happened during and after the last war. Hence, the smart thing for you to do is to look ahead to the future too. Protect your invention by applying for a patent now, so you will be in position to cash in on an outright sale, or on the royalties your invention will bring.

Patent Guide Shows What To Do

Our "Patent Guide for the Inventor" answers many important questions concerning Patents that inventors constantly ask. It tells what facts, details, drawings, sketches, etc. are necessary to apply for a Patent; how to protect your invention through dated and witnessed disclosure; how to do this AT ONCE to safeguard your rights; how Patent Office Records can be checked to determine whether the invention is probably patentable before filing fees need be paid, discusses costs involved and a practical way these can be paid as the application progresses. It tells how some inventors secured financial backing; how many simple inventions have proved large commercial successes; how Patents covering improvements also can be profitably utilized and marketed; tells countless other facts of interest.

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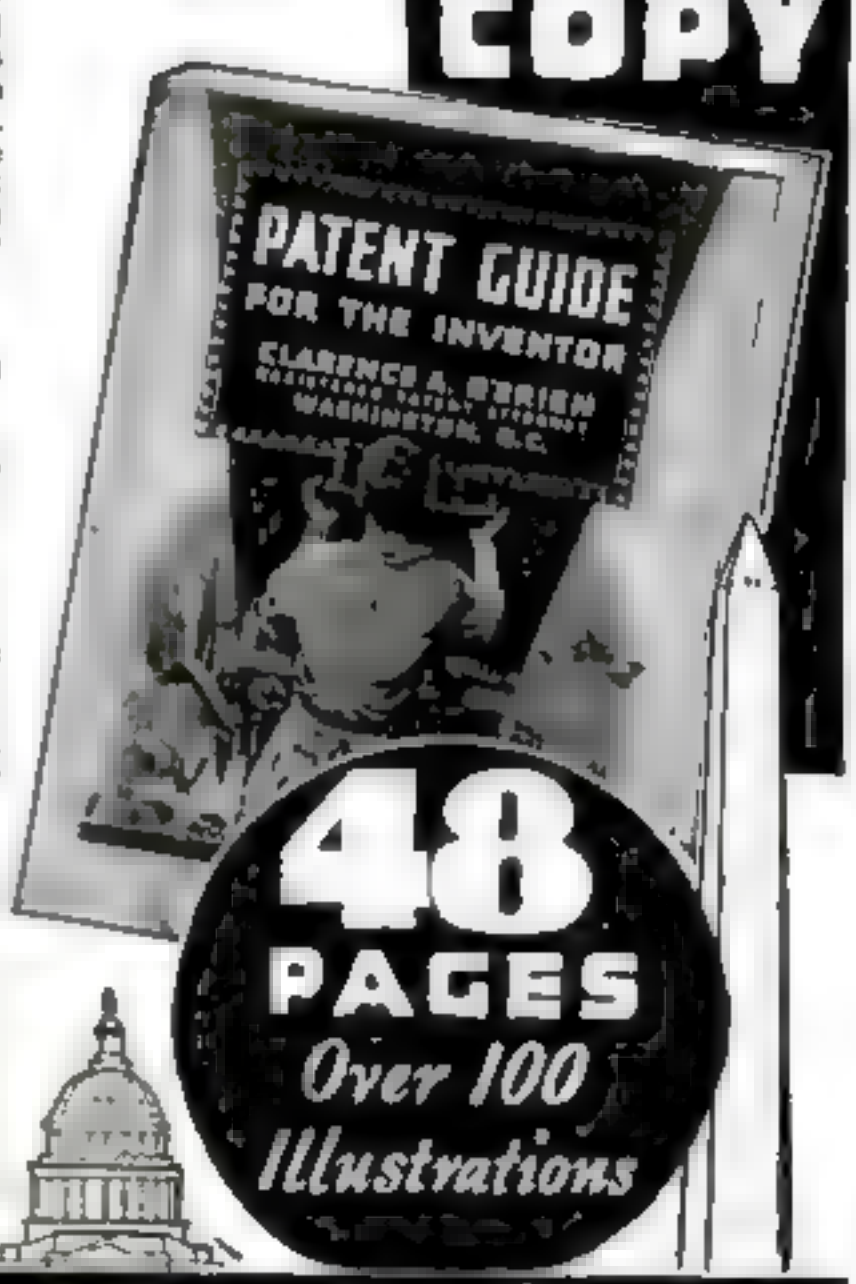

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Readers Say:

Dad Gets His Orders on Holding the Home Front

MY SON, Roy, is at present in the Army, and therefore not in a position to answer the inquiry that you recently sent to him. However, his most specific request just before leaving was that we take good care of every copy of P.S.M., and that under no circumstances are we to allow the subscription to expire.—F. C. U., Muncie, Ind.

Thanks, F. C. U. Roy's letter made us feel mighty proud. We would appreciate it if you'd tell him that we, too, are looking forward to his enjoying those back copies. —Ed.

Credit the Italians. They Always Come to a Fast Stop

IN "READERS SAY" of your January issue you published a letter from W. Y. of Hayden, Arizona, who outlined his idea for an airplane propeller whose pitch could be reversed to bring the plane to a quick stop. In this connection, I think you might be interested to know that back in 1939 the Italians carried out extensive experiments on seaplanes with just such a propeller. As soon as the plane touched the water, the propeller pitch was reversed and the plane came to a stop almost immediately. Credit for the invention, however, should not go to the Italians, for the idea originated in this country.—J. R. D.

But What if a Dog Just Doesn't Like to Keep House?

DO YOU mean to infer by your statement in Un-Natural History of the October issue that a dog does not know why he turns around several times before he lies down? How idiosyncratic of you! It is entirely obvious, and common sense will tell you, that he turns around to make his bed and to pat it to suit his shape, just as a woman makes and pats a bed.—A. H. T., North Platte, Neb.

From the News Editor's Desk

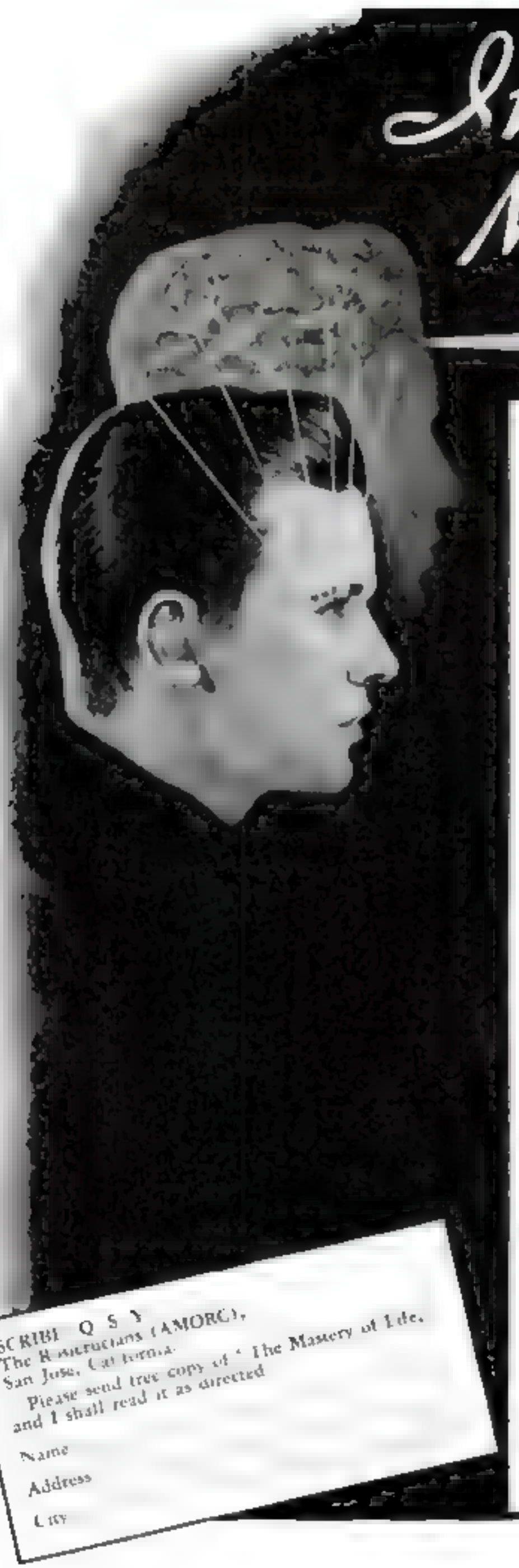
EVERY MILITARY COMMANDER should have a psychiatrist on his staff, according to Dr. Emilio Mira, of the University of Buenos Aires. Under the terrific strain of seemingly unending battles that seldom gives them a chance to rest, Dr. Mira says, military leaders are very apt to push themselves far past the limits of their nervous endurance. The result may be a bad emotional crack-up symptomized by smoldering resentment, drunkenness, or sudden explosive behavior. To prevent this dangerous situation, Dr. Mira has devised a simple 10-minute test called a Myokinetic Psychodiagnosis by which, he says, an officer's mental and emotional fitness can be precisely determined at any given moment.

PREVENTION OF SABOTAGE is no longer exclusively the happy hunting ground of Edgar Hoover's ever-alert agents. Mechanical "detectives" are now ferreting out trouble spots in power-generating equipment and are saving machines from breakdowns which might seriously hamper production. One of these instruments recently gave warning of unusual vibration in a generator shaft. Inspection revealed an incipient crack which, if it had been neglected, would have crippled the plant for weeks.

A SURGICAL DRESSING for wounds and burns that looks like wax paper, but which carries a germicidal Sunday punch in its 30 to 50-percent content of sulfadiazine, has been developed by Dr. Kenneth Pickrell of Johns Hopkins. In the treatment of burns, the sulfa drug film is placed over the scorched area, and on top of that is applied a smooth, firm-pressure gauze dressing. New skin usually begins to form after three to five days. Most unusual feature of the treatment, however, is that the sulfa film is translucent, which allows the surgeon to inspect the burn without removing the film.

OF THE MANY FREAK ACCIDENTS that the war has produced to date, the leading candidate for believe-it-or-not honors took place when a British aviation student fell out of a training plane at 500 feet. He appeared to be on his way to oblivion when suddenly something struck him on the head. Snatching at it frantically, he found himself clutching the tail of his plane. He climbed aboard and landed unhurt.

SPECIALIZATION IN WAR has now reached an all-time high with the announcement that a new type of diet for aviators has eliminated a major source of aviation accidents. A Canadian company confirms the premise by revealing that highly nutritious lunches for its employees have resulted in increased production. England adds to the evidence with the statement that a special diet for nursing babies and pregnant women has reduced infant mortality 20 percent.



In Your Mind's Eye

The Secret of MENTAL CREATING

IF you just like to dream, read no further. There comes a time when your fancies *must be* brought into light—and stand the test of every-day, hard realities. Are you one of the thousands—perhaps millions—whose thoughts never get beyond the stage of *wistful wishing?* Do you often come to from a daydream with the sigh, "If only I could bring it about—*make it real!*"

All things begin with thought—it is what follows that may take your life out of the class of those who hope and dream. Thought energy, like anything else, can be dissipated—or it can be made to produce actual effects. *If you know how to place your thoughts* you can stimulate the creative processes within your mind—through them you can assemble things and conditions of your world into a happy life of accomplishment. *Mental creating* does not depend upon a magical process. It consists of *knowing how* to marshal your thoughts into a power that draws, compels and organizes your experiences into a worth-while design of living.

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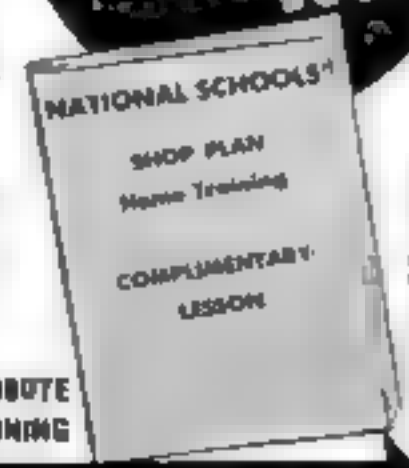

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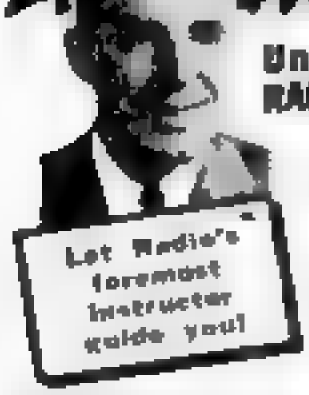

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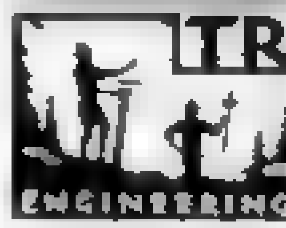

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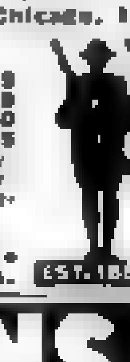

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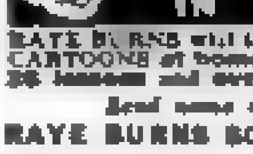

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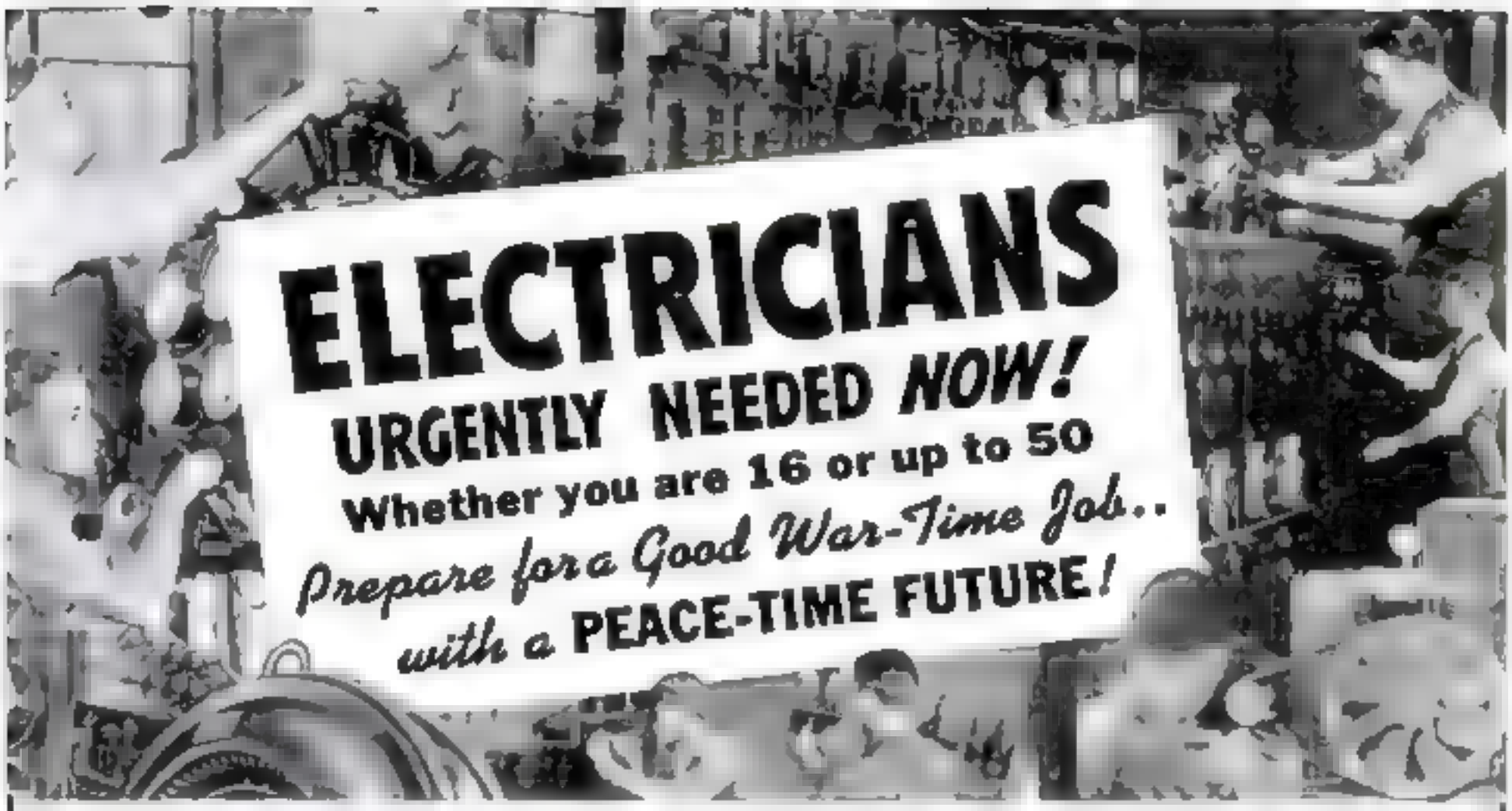

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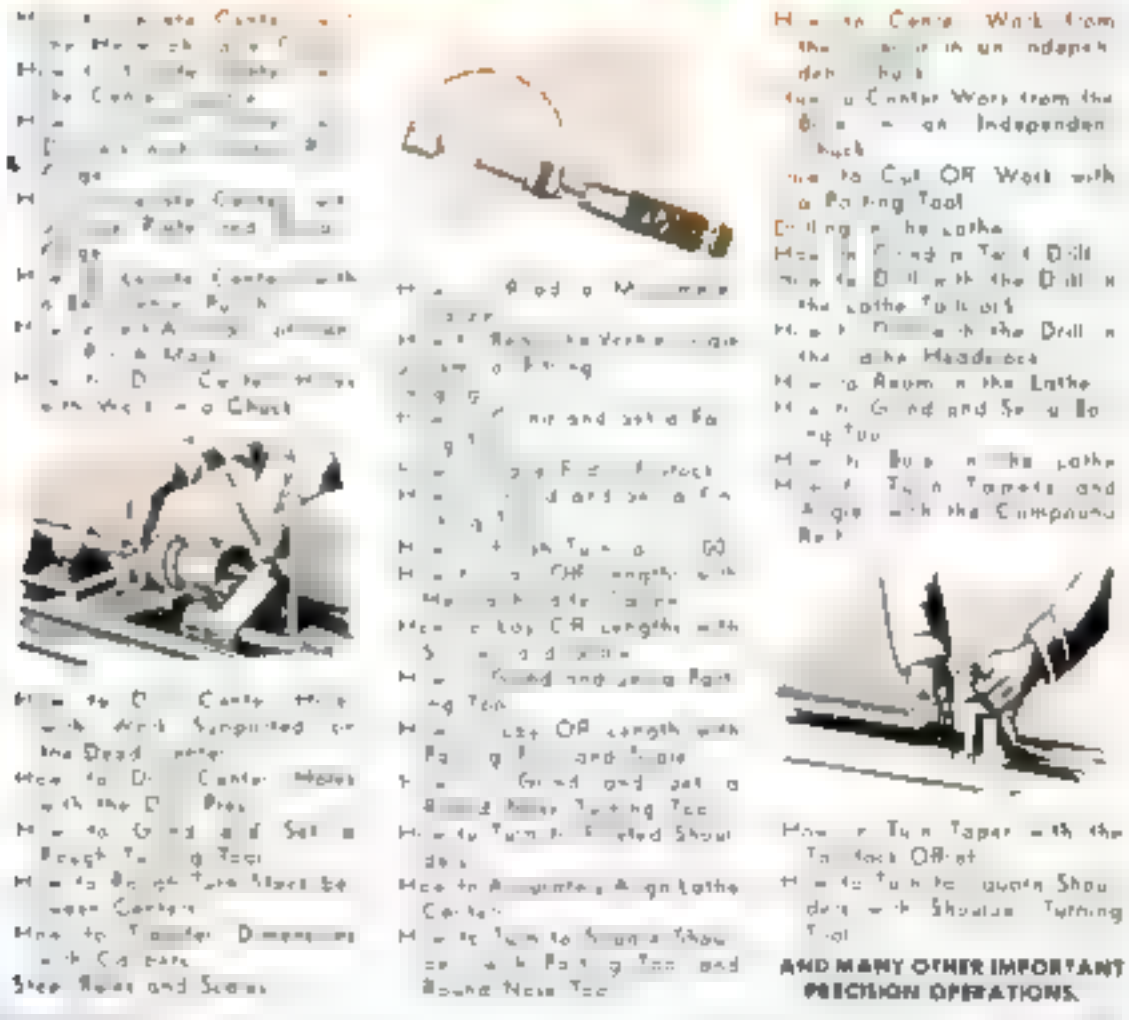

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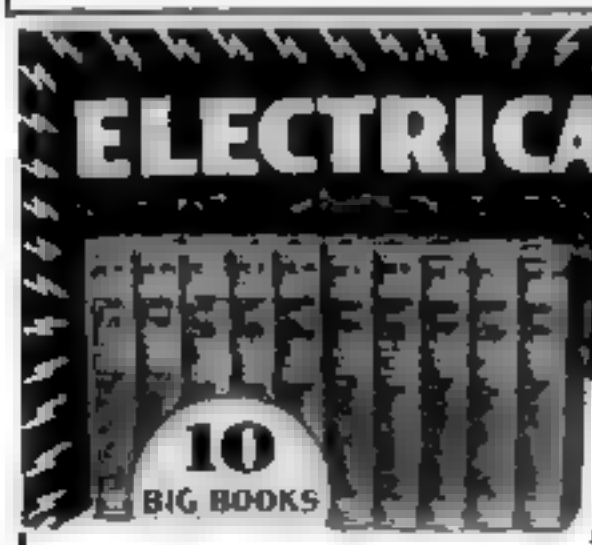

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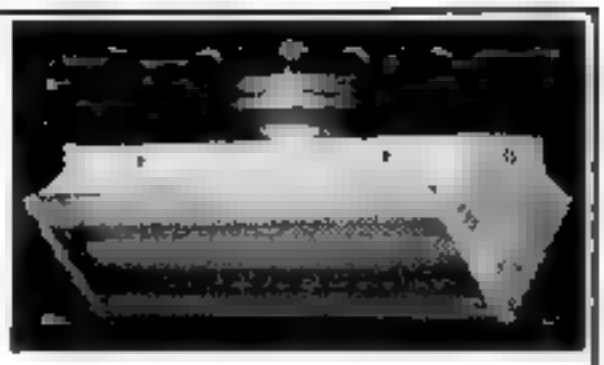

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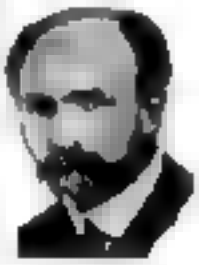

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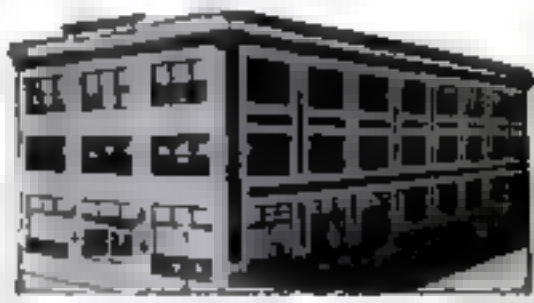

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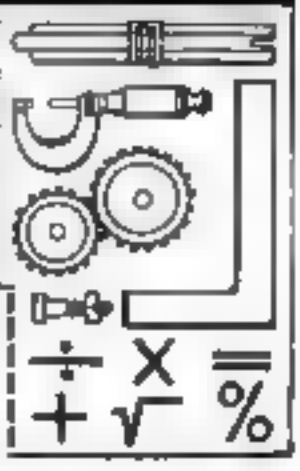

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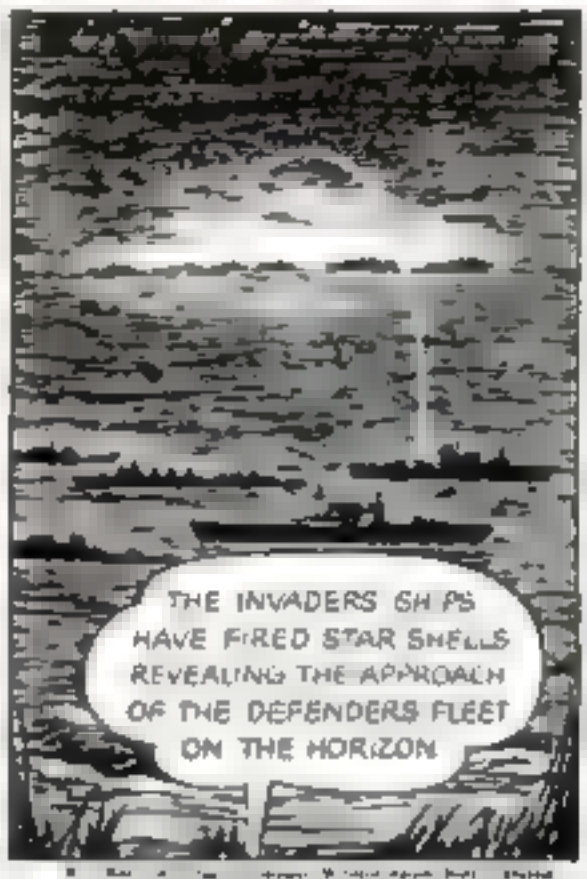

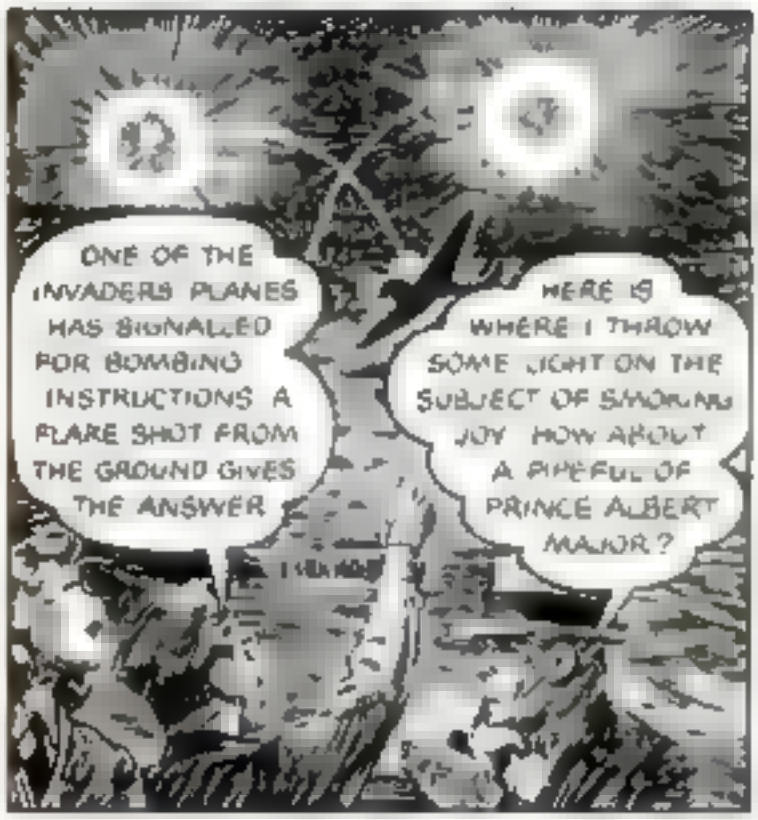

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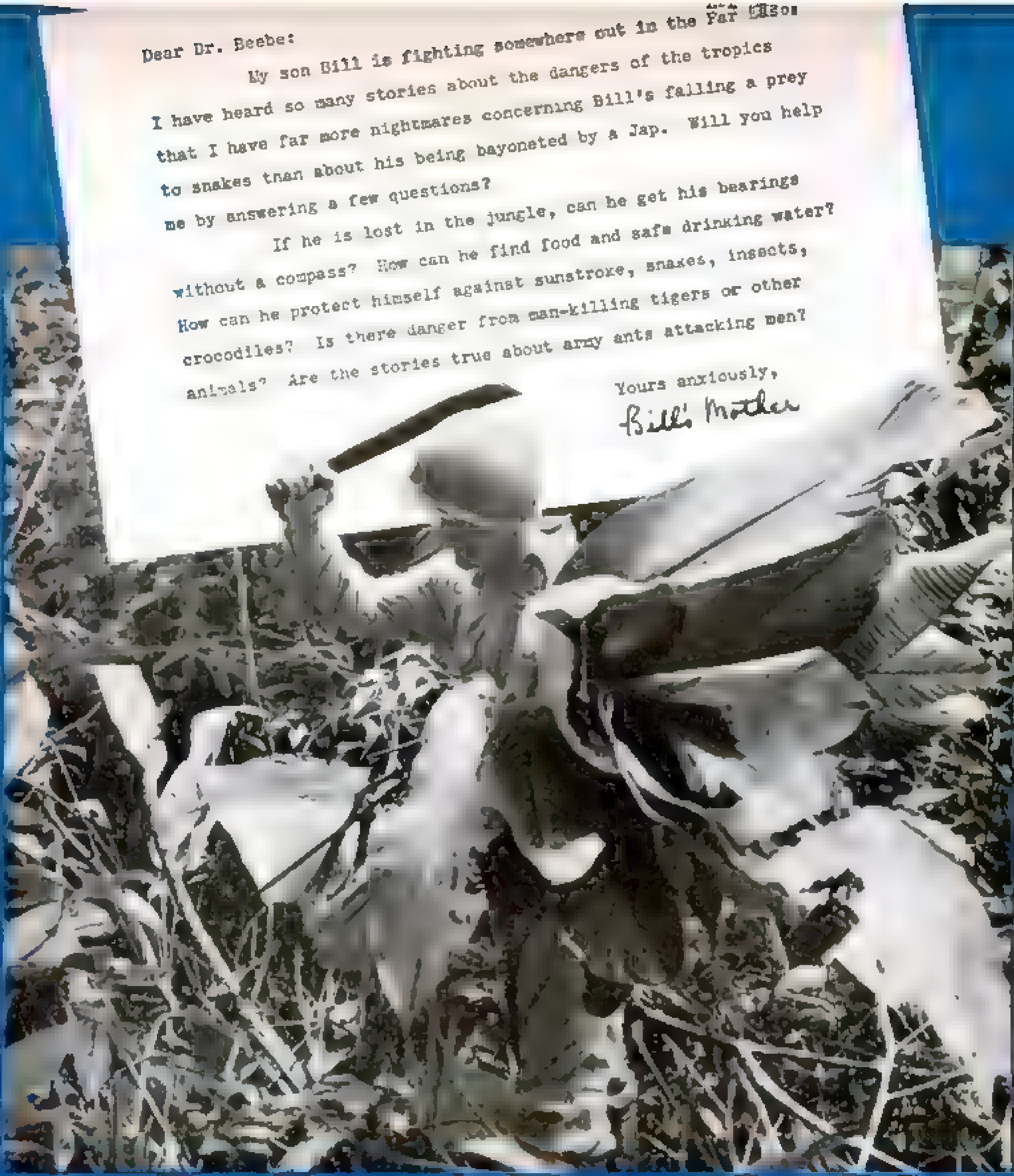


Dear Dr. Beebe:

My son Bill is fighting somewhere out in the Far [illegible] I have heard so many stories about the dangers of the tropics that I have far more nightmares concerning Bill's falling a prey to snakes than about his being bayoneted by a Jap. Will you help me by answering a few questions?

If he is lost in the jungle, can he get his bearings without a compass? How can he find food and safe drinking water? How can he protect himself against sunstroke, snakes, insects, crocodiles? Is there danger from man-killing tigers or other animals? Are the stories true about army ants attacking men?

Yours anxiously,

Bill's Mother

A FAMOUS EXPLORER TELLS YOU

How Lost Jungle Fighters Can Survive

By WILLIAM BEEBE

THE letter above is a composite of scores I have received, and of many conversations. Perhaps this is a good time to give a comprehensive answer. I began my explorations in tropical jungles about 25 years ago

[illegible] Venezuela. This experience has left me with an undying affection for these mighty trees and the wild creatures which live in their shadow, but this emotion is combined with a thorough respect which ever increases.

What I write is a direct answer to the

A jungle stream like this one in Malaysia offers an easy path through thick growth, and its water is safer to drink than that of stagnant forest pools. Islands afford sleeping places free from leeches.

to know the truth. I shall make use of the greatest handicap in outfit and location. Let us suppose a soldier has landed safely by parachute in the heart of the Malay jungle, or has straggled far from the line of march and is completely lost. I shall allow him nothing but his clothing—which is manifestly unfair, but if he is to be furnished with gun, knife, matches, and compass his plight would be altogether too easy.

Let us say our lost soldier knows that he ought to go west to find his line of march, or to reach friendly Malays on the west coast. His only guides will be the rising and the setting sun; and at night, through occasional openings, the Southern Cross. He must have water, food, and safety, and to achieve these his first object should be to find a stream, to which an animal trail usually will lead him. The water of such a stream will be far less dangerous than the dysentery-breeding pools and swamps of the jungle itself. Also if he keeps to the stream bed, progress will be infinitely easier than forcing a way through the thorny tangles, and he is sure to find isolated rocks, or fallen tree trunks or islets where he can hope for reasonable isolation from the multitude of leeches which elsewhere will sap his strength while he sleeps. In addition there is often a strong current of air near and over running water which would diminish any swarms of mosquitoes. Vast areas of jungles in all parts of the world are wholly free from such pests as leeches, ticks, and mosquitoes, but I am being as hard as possible on our wanderer.

If I deny him matches he must eat his food raw. While this is unpleasant at first, it is not nearly as bad as it sounds, and existence on such provender is a welcome change from the gnawings of hunger. I have eaten grubs, lizards, frogs, snakes, monkeys, and many other creatures the very mention of which makes the city-bred person shudder, even at the very moment when he or she is, with great relish, devouring live oysters. The items I have men-

DR. WILLIAM BEEBE knows and loves the jungle from long experience. In the last 35 years he has ventured into tropical wilds in many parts of the world to study wildlife and obtain specimens for zoos and museums. On his latest trip, to eastern Venezuela, he discovered new species that throw light on the theory of evolution.

Monkeys and birds will show our lost soldier what jungle fruits and berries are edible. These are gibbons, which live in bands and fill the treetops with their noisy chorus.

tioned have been cooked, but if faced with imminent starvation I would not hesitate a moment to eat them raw. Giant grubs can be dug from almost any rotten stump, and when cooked, taste like roasted peanuts. The other, more active ingredients on our jungle menu must be caught with the bare hands or killed with a stick.

Vegetable food in a tropical jungle is a more difficult matter. Succulent leaves and roots are all about; delicious-looking fruits, berries, and nuts abound, but only the pressure of extreme hunger would tempt me to taste any of these without the example of a monkey or bird to assure me of their edibility. If only one can see a gibbon or a flock of parrots feeding, then fruit or nuts can be eaten freely.

The supposed terrors of tropical jungles sink into insignificance beside the problem of finding food. In the course of a score of expeditions I have been attacked only twice by poisonous or harmless snakes, and on both occasions the reptile was actuated by confused fear. In Malaysia our soldier may encounter a python 20 feet long, in addition to leopards, tigers, elephants, and rhinoceroses, yet the chances are 100 or 1,000 to one of their attacking, if he is able to walk or move about and thrash the undergrowth with a stick. Cobras and vipers live in these jungles, but there is more danger from rattlers and copperheads on the Palisades opposite New York City than in any tropical forest I have ever explored.

If our man lies down and in his sleep is attacked by army ants, he will awake at the first stinging bite. If he is helpless

These harmless-looking yellow berries are deadly poison. Monkeys know better than to eat them

. . . while this scarlet fruit has been pecked at by pheasants—proof that it is edible

Land leeches like this are not poisonous but they suck the blood, causing weakness and infection

The Indian cobra is found also in Malaysian jungles. It rears its head and spreads its hood when it is approached, but never attacks unless first provoked

Russell's viper is the most dangerous snake of the jungle because its camouflage makes it blend with the forest floor. If trodden upon, it will sting

from weakness he will be killed within a half hour. Otherwise all he needs to do is to brush off those which have reached him, walk or run a few yards to one side and the danger is past. Indeed I have found these ants, both in the jungles of the Orient and in South America, to be invaluable as assistants in collecting insects, reptiles, and birds. Every living creature in their path is aroused to instant, terrified, headlong flight. If I had need of the flesh of these animals for food I would arm myself with stick or club and hunt in the van of an army of driver ants, certain of bagging many creatures whose fear would make them easy prey.

Spiders, centipedes, tarantulas, and scorpions can all be discounted as real dangers, for the same reason that one does not voluntarily put one's hand into a wasp's nest. Neither does he die if stung by one or a few of these pests. Crocodiles can be a menace under certain conditions, but any river can be safely crossed on a floating log or a rough raft of boughs and limbs of trees. In the twilight of the jungle neither sun helmet nor hat of any kind is needed. Shelter in the jungle where there are palms is an easy problem. A single frond makes a good umbrella, and a dozen provide a satisfactory tent.

Strangely enough, as our refugee approaches the haunts of man his dangers increase. Not from the natives themselves, although they would probably be too shy to show themselves and offer help. The Malays are friendly folk and after they have had one experience with the Japs they would doubtless give all possible aid to a white man. Malaria and the danger from dysentery would increase in the vicinity of a native village, and if any tiger ever threatened attack it would be an old, toothless animal whose beat was somewhere near the huts of human beings. The worst danger here would be from the herds of semidomesticated water buffalo, the most picturesque and deadly animals in the world. When once they scent a white man for the first time, only the convenient limb of a tree will save him from sudden death. I have spent four miserable hours astride a most uncomfortable branch, with an enraged buffalo on the ground below playing jackstraws with my gun and camera. I finally was rescued by a completely naked,

Army ants on the march. No living creature can withstand their attack, but an able-bodied man can get out of their way and even use them to scare up animals for food

eight-year-old native who batted the animal over the snout and drove him off

Perhaps the most dreadful danger of all may exist in the mind of the lost man. To a human being ignorant of these jungles every sound, every rustle will seem to presage some unknown horror. The hammering of a pair of giant woodpeckers is the rattle of machine guns; the trumpeting of a distant elephant is a military bugle, the swish of leaves marking the flight of a tree shrew is imminent attack from some death-dealing animal. As a matter of fact, what the city-bred man would consider a supreme horror of horrors, probably never reaches his consciousness: the ambushing black leopard will scent and hear an oncoming man long before he comes within sight, and the cat, in all probability, will make his escape without a sound; the python coiled in the trail will slip aside at one's noisy approach. And when a city man tries to catch a lizard clinging to a tree trunk, and sees him spread wings and sail off through the air, he must not jump to the conclusion that his mind is going. Flying lizards are common in these jungles and the flesh of their limbs is as tasty as that of frogs' legs

Especially must one not be deceived by the short but lusty crowing of bantams The sound comes not from a near-by village, but from wild jungle fowl, the ancestors of all the chickens in the world.

If at last one can follow a stream until it reaches the sea, all immediate risks are over. Along the shore is an abundance of mussels and other shellfish; coconut palms are almost a certainty, and sooner or later a native proa will come sailing into view

As far as the Japs are concerned, they are lower than any beast of the jungle which kills only for food. If our soldier at last reaches safety, and again, with weapons in his hands, faces those yellow men who have belied the name of man, I can only wish him "Good Hunting."

Don't think you're going nuts if you see a lizard take off and fly. Flying lizards glide just as flying squirrels do

Most dangerous animal in the Malay jungle is the half-domesticated water buffalo. White man's scent maddens them

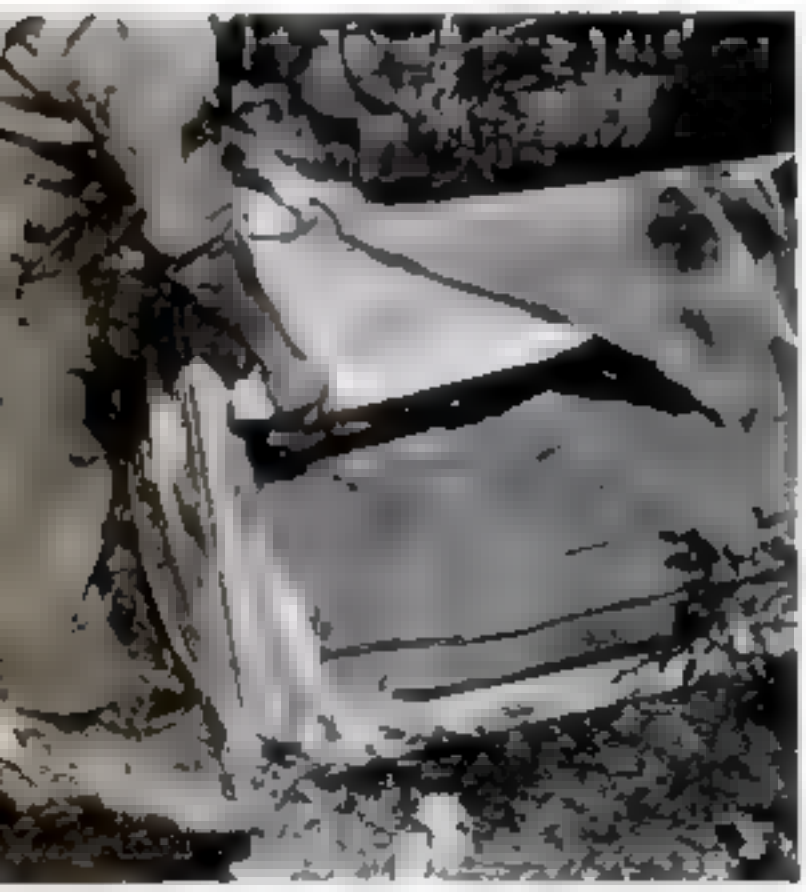
Comfortable shelter is provided in any climate by this new Army tent, put up with four light aluminum tent poles

Pup Tents for Army Flyers Designed for Modern Comfort

SLEEPING in jungle, desert, or arctic waste—or wherever their tasks may take them—still means a good rest for Army flyers equipped with the Air Corps A-2 shelter, this war's modern descendant of the pup tent. It is a highly portable, waterproof covering that can be put up in a few minutes with four light aluminum tent poles and is easily camouflaged. Ventilating windows can be locked shut if the weather requires, and mosquito bar protects against insects. The tent's pneumatic mattress is inflated simply by kneeling on an inflating bag.

Air is forced into a specially designed pneumatic mattress simply by kneeling on the ingenious inflating bag shown at the left above. Five "kneels" on the bag usually are enough

A sleeping bag that goes on top of the mattress is lined with warm quilting. Blankets can then be buttoned on with snaps

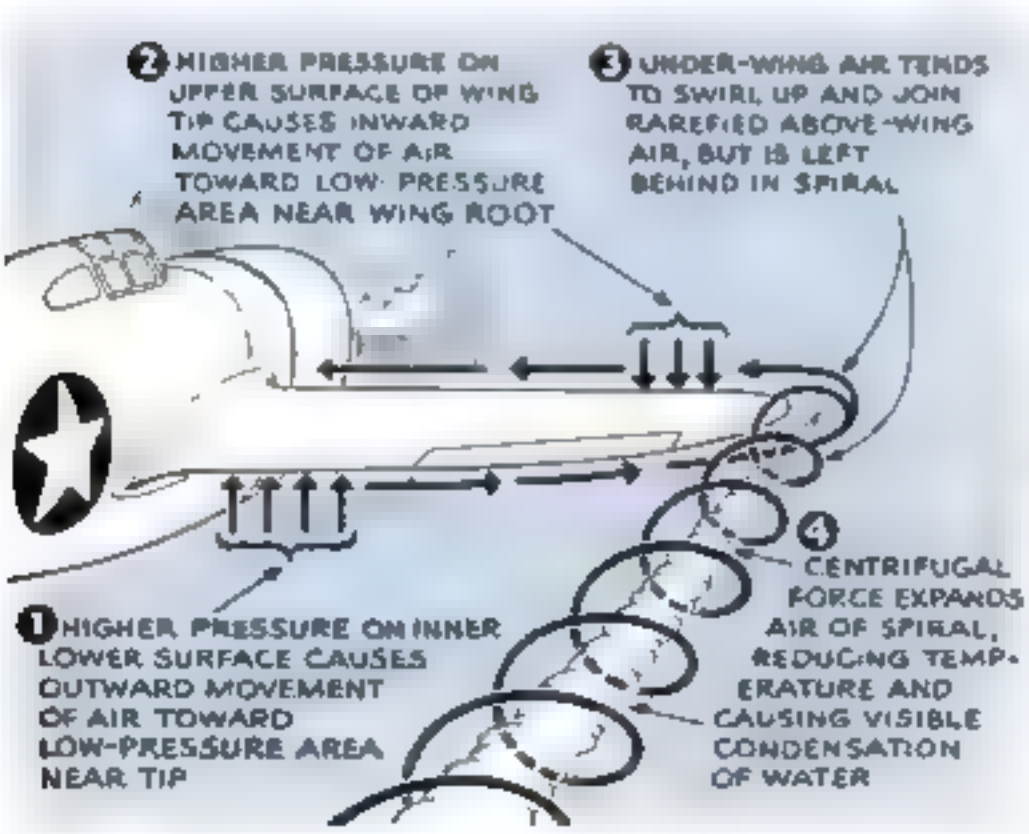


Mosquito netting in the top part of the tent can be rolled down when it is required for protection against insects. Ventilating windows in the ends are closed with slide fasteners

WHY PLANES MAKE *Vapor Trails*

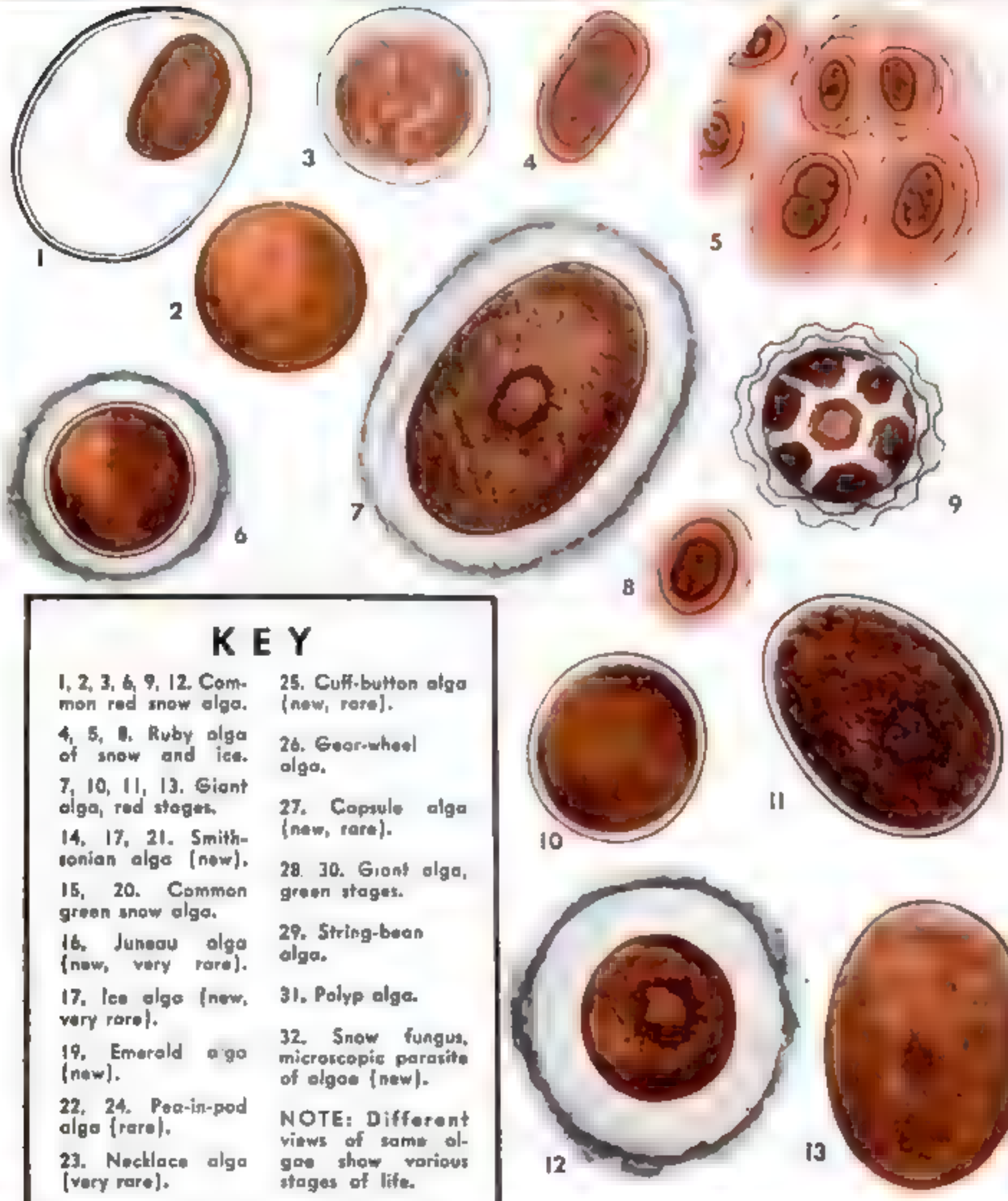
AIRPLANES leave trails in the atmosphere that can be picked up, if a spotter is quick enough, like those of game sought by a hunter. Some of them, especially trails left by a plane's exhaust at high, cold altitudes, endure for some time, while those made by wing tips creating vortices are audible as well as visible.

Both of these types of airplane trails are explained by condensation. Invisible water vapor in a plane's exhaust condenses into a visible cloud when the vapor reaches an excess of what the atmosphere will hold. Wing-tip trails add no water to the air, but as their vortices expand, the air temperature in them drops and the dew point is reached if the vortices are strong enough and humidity is high.



Noise like the whistle of a falling object may be heard when a heavily loaded plane pulls out of a low dive. It is from the wing-tip trail illustrated at left, and is audible after that of the motor dies away

Microscopic Plants



KEY

1, 2, 3, 6, 9, 12. Common red snow algae.

4, 5, 8. Ruby algae of snow and ice.

7, 10, 11, 13. Giant algae, red stages.

14, 17, 21. Smithsonian algae (new).

15, 20. Common green snow algae.

16. Juneau algae (new, very rare).

17. Ice algae (new, very rare).

19. Emerald algae (new).

22, 24. Pea-in-pod algae (rare).

23. Necklace algae (very rare).

25. Cuff-button algae (new, rare).

26. Gear-wheel algae.

27. Capsule algae (new, rare).

28. 30. Giant algae, green stages.

29. String-bean algae.

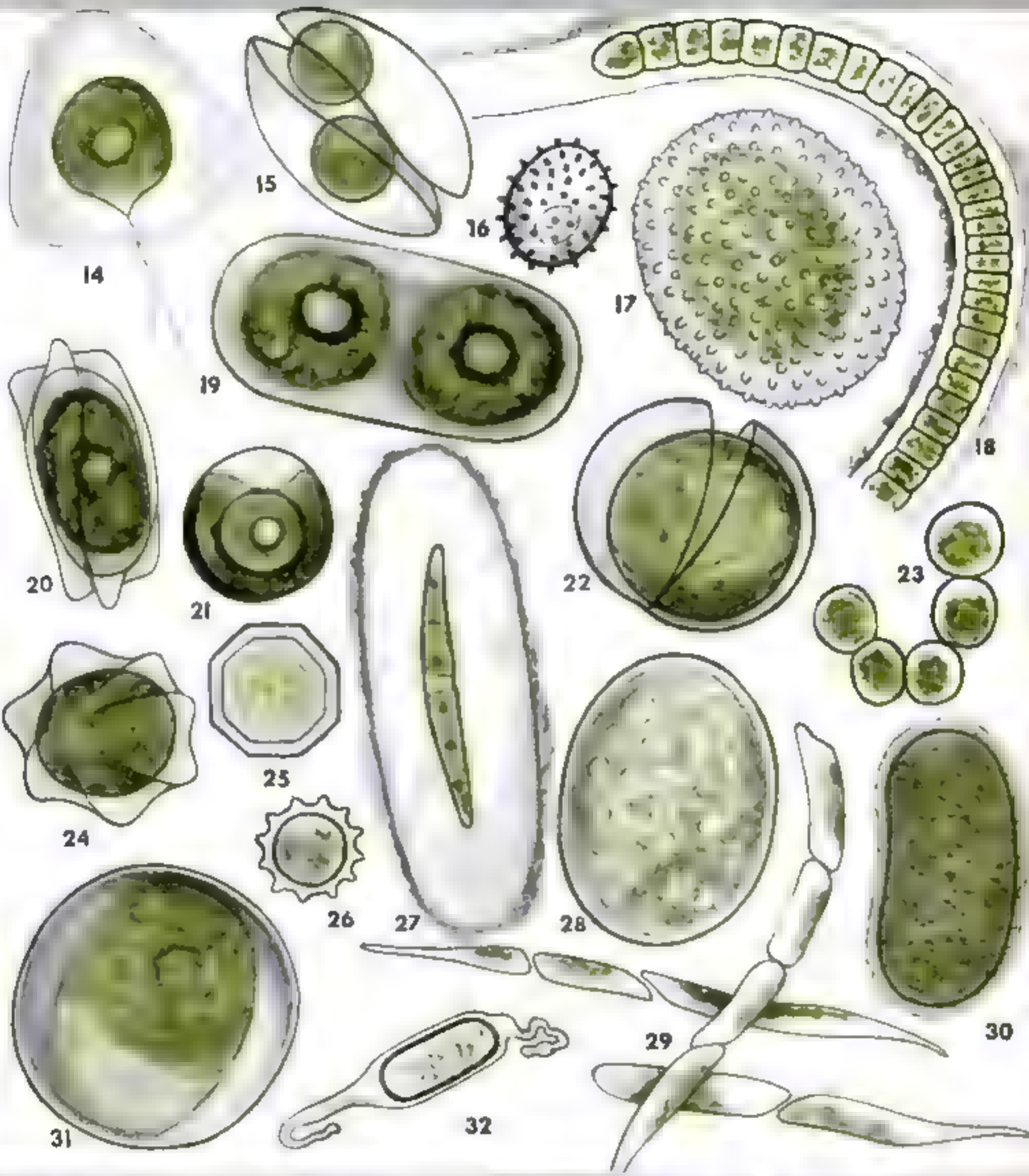
31. Polyp algae.

32. Snow fungus, microscopic parasite of algae (new).

NOTE: Different views of same algae show various stages of life.

RED, green, purple, and yellow fields of snow and ice—rare curiosities of nature—owe their hues to myriads of microscopic, cold-enduring plants. Some of the world's most striking displays recently have been discovered and studied in Alaska by E. Kol, Hungarian woman scientist. High on Thompson Pass, she reports, vast expanses of snow appear as if sprinkled with red pepper. Ice of the Columbia Glacier, extending miles along the coast, blooms with a purplish color. Mixed colonies of the plants, which belong to the family called algae, give blends of hues.

Paint Arctic Snows



Nearly half of the 30 kinds of algae found by the explorer are new to science. To one she has given the name "Smithsonimonas Abbotii" in honor of the Smithsonian Institution, which sponsored her expedition, and of Dr. Charles G. Abbot, its secretary. This and some of her other finds are illustrated here. Certain algae live only on snow; others, only on ice; and some, on either. Rock dust, called cryoconite, feeds them.

Even microscopic plants have their parasites. The Alaskan trophies include two hitherto unknown varieties of "microfungi," one of which is shown above.

A Vectograph of a given landscape can be reproduced any number of times, so that each man engaged in an operation can carry one and study it through polarizing glasses wherever he may be. Picture No. 2 on the opposite page shows how the road in the Polaroid Vectograph at right appears in a relief print

Polarized Light for the Eyes of the Army

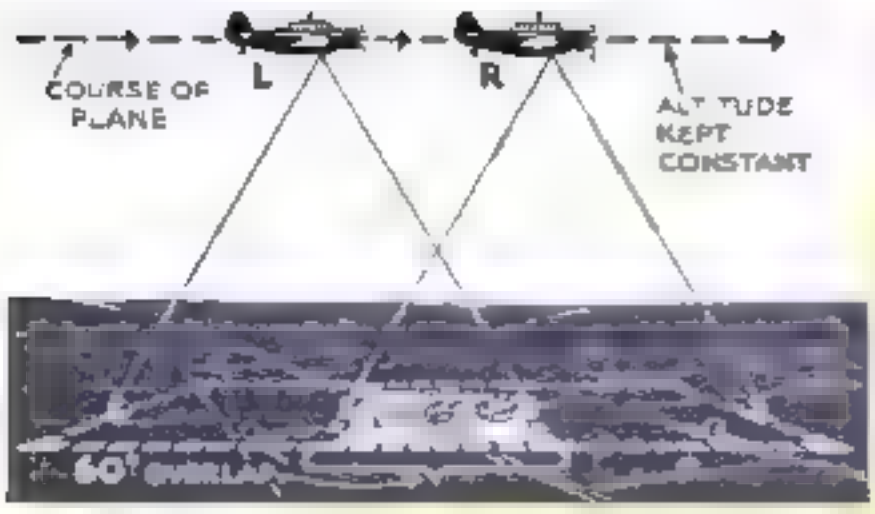
NEW AERIAL PICTURES SHOW ENEMY TERRITORY IN THREE DIMENSIONS

By ALDEN P. ARMAGNAC

ENROLLED in classes at a Cambridge, Mass., laboratory, picked men of the Army, Navy, and Marine Corps are learning a new way to make aerial photographs possessing depth, or a third dimension. The pictures clearly reveal bomb damage to industrial plants. They pierce such camouflage as false shadows and make-believe "gardens" painted on roofs of war factories. Vividly they show the contours of shore lines, cliffs, hills, and valleys in enemy-held territory. Trees, ditches, and bushes, important in providing cover, appear in full relief like an exact-scale model.

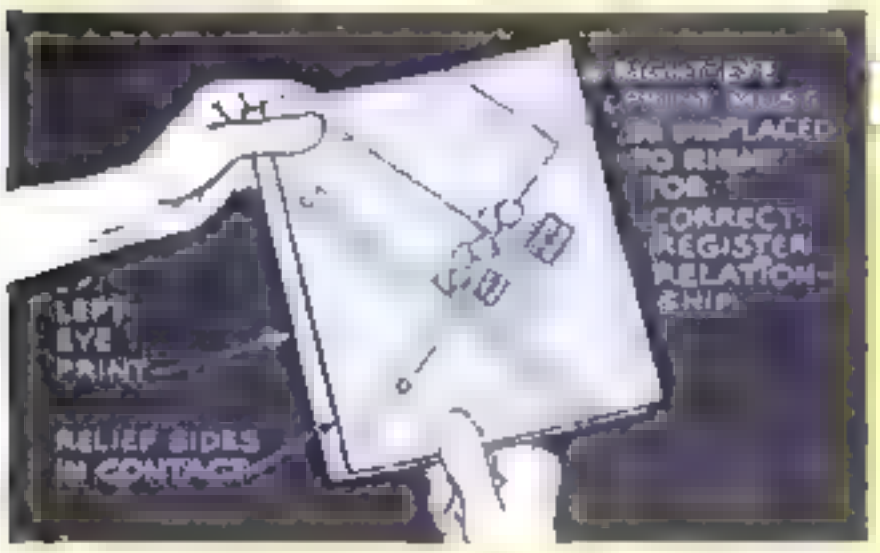
From brief study of such a picture, too, a military strategist may deduce the loca-

The process of making Vectographs is shown on the opposite page. How these Vectographs may be used, both as still pictures and as moving pictures, appears on pages 60 and 61

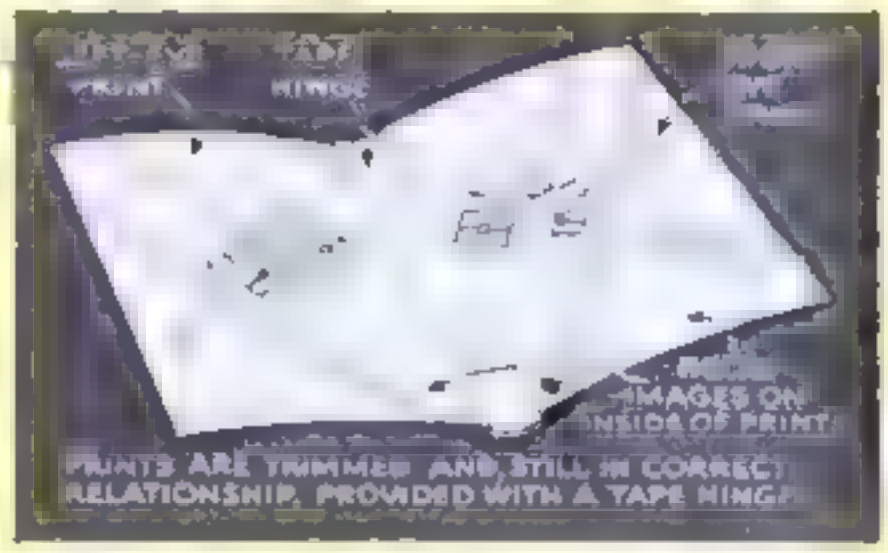


1 In shooting a scene from a plane, the photographer takes two overlapping pictures: one for the right eye, the other for the left

2 One of the negatives is reversed in printing, and both pictures are transferred to a relief pattern composed of hardened gelatin

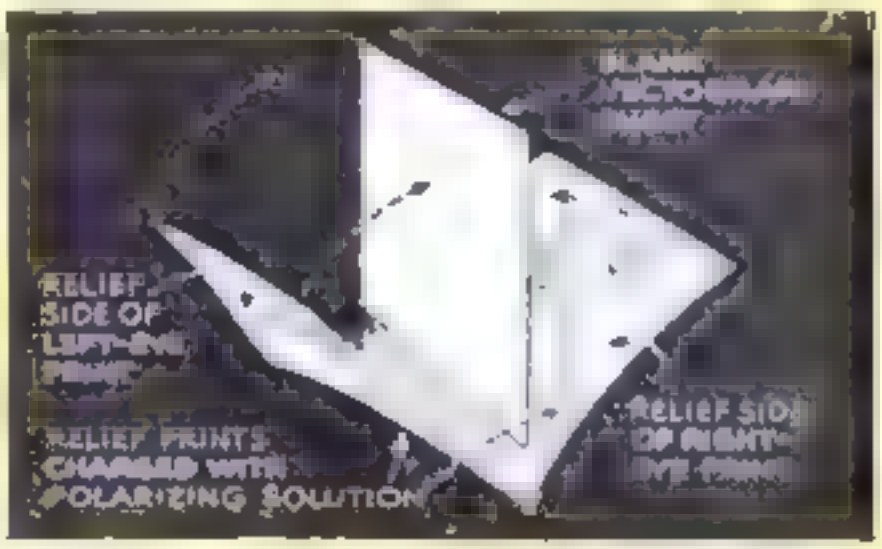


3 Here the gelatin sides of the prints are placed face to face, then adjusted so that the final Vectograph will have a double image



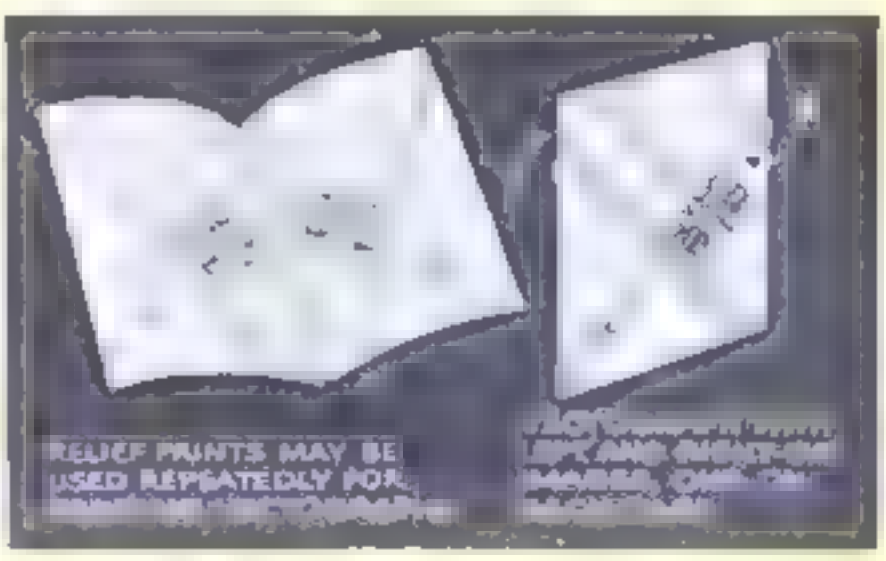
4 Prints are now taped to hold them firmly in adjustment. Contour of reliefs is in relation to lights and shadows of original scene

5 Placed in this bath for 30 seconds to two minutes, the gelatin absorbs the polarizing fluid, the thick part soaking up the most



6 Preparatory to the pressing operation, a sheet of transparent plastic is carefully placed between the faces of the relief prints

7 Hinge first, the "sandwich" is put through a pair of rollers which press the relief sides of the prints against the plastic sheet



8 The "two-faced" Vectograph finally emerges. When examined through a pair of polarizing glasses, it presents a vivid stereoscopic view

For concerted examination, a Vectograph of enemy territory can be projected on a screen and viewed through polarizing spectacles. Or it can be used to supplement map study. Instead of spectacles, men in action may carry cardboard viewer at left

tions of hostile strong points, and how they may be taken by a surprise raid, or reduced in a full-dress invasion. By projecting the pictures on a screen, a leader may instruct his men exactly in the individual parts they are to play. Finally, since an unlimited number of duplicates of a picture may be made, every man going into action may carry his personal copy, together with a simple card viewer for examining it—in a fox hole, aboard an assault boat, or even inside a tank.

The same process, with little or no modification, offers fascinating future possibilities to amateur and professional photographers. Still and motion pictures, both in black-and-white and in color, will be endowed with the final realism of depth. The stills may be mounted in albums, or finished as transparencies. Tridimensional color movies, long the dream of inventors, will assume such practical form that they may be exhibited with standard home and theater projectors. All these innovations have been perfected. Their introduction to the public awaits only peace. Until then, the entire production of the Polaroid Corporation, maker of the materials, is filling U. S. war needs.

Military classes produce the relief photographs, called Vectographs, in

An instructor demonstrates the hinging together of the two relief prints from which a Vectograph is made, and below, Army technicians work on the developing process

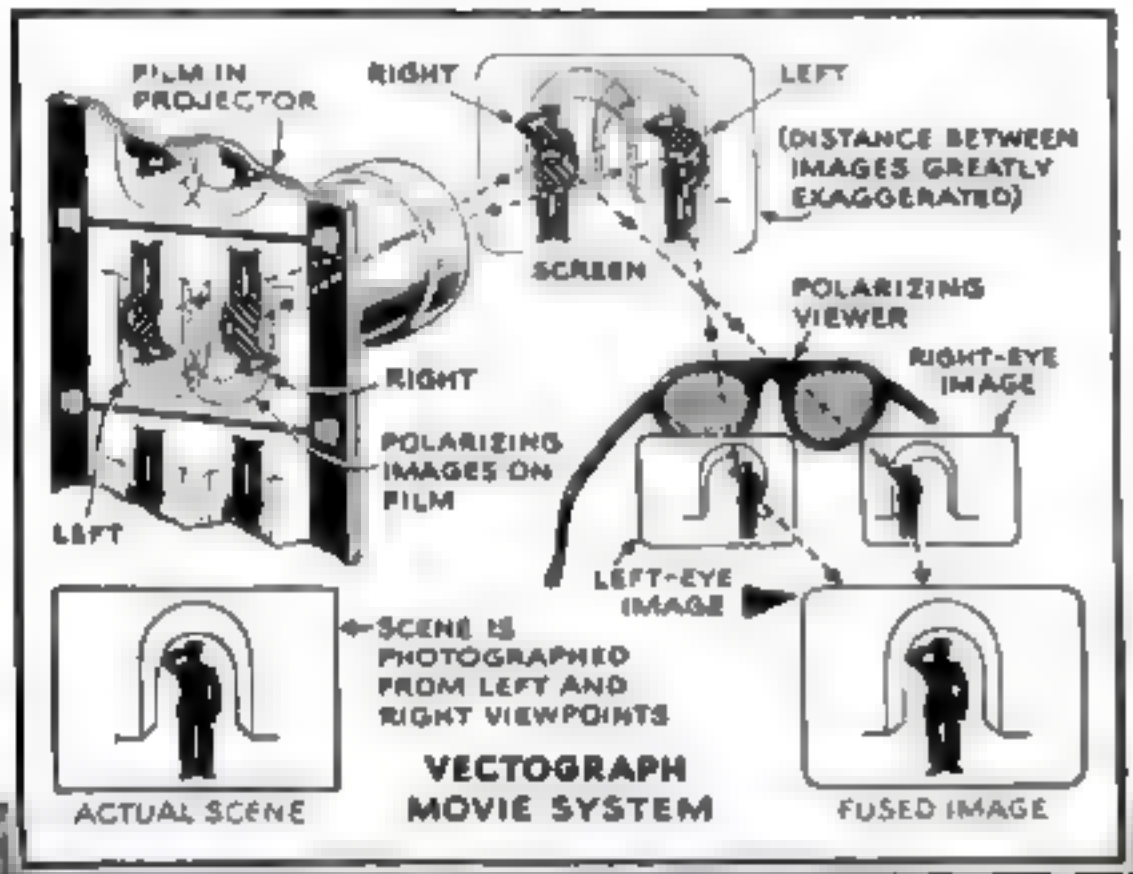
their first day of instruction. Simplicity of the procedure contrasts with the remarkable combination of optical and chemical principles underlying it. Credit for the process goes to a research team directed by Edwin H. Land, the same brilliant young inventor whose Polaroid, the first practical light-polarizing material, startled the scientific world some years ago (P.S.M., April '38, p. 20). Vectographs also use polarized, or "one-way," light, vibrating in only one plane, but produce it in a new way. Watching a Vectograph made helps to make the idea clear.

Raw material consists of a pair of stereoscopic, or left-and-right-eye, negatives which may be made with the simplest of box cameras by shifting the camera between two successive exposures. For stopping motion, professionals use a more expensive camera with twin lenses and synchronized shutters. In the air, a pair of overlapping pictures made some distance apart gives the effect of looking through a giant's eyes, greatly heightening the scale of relief.

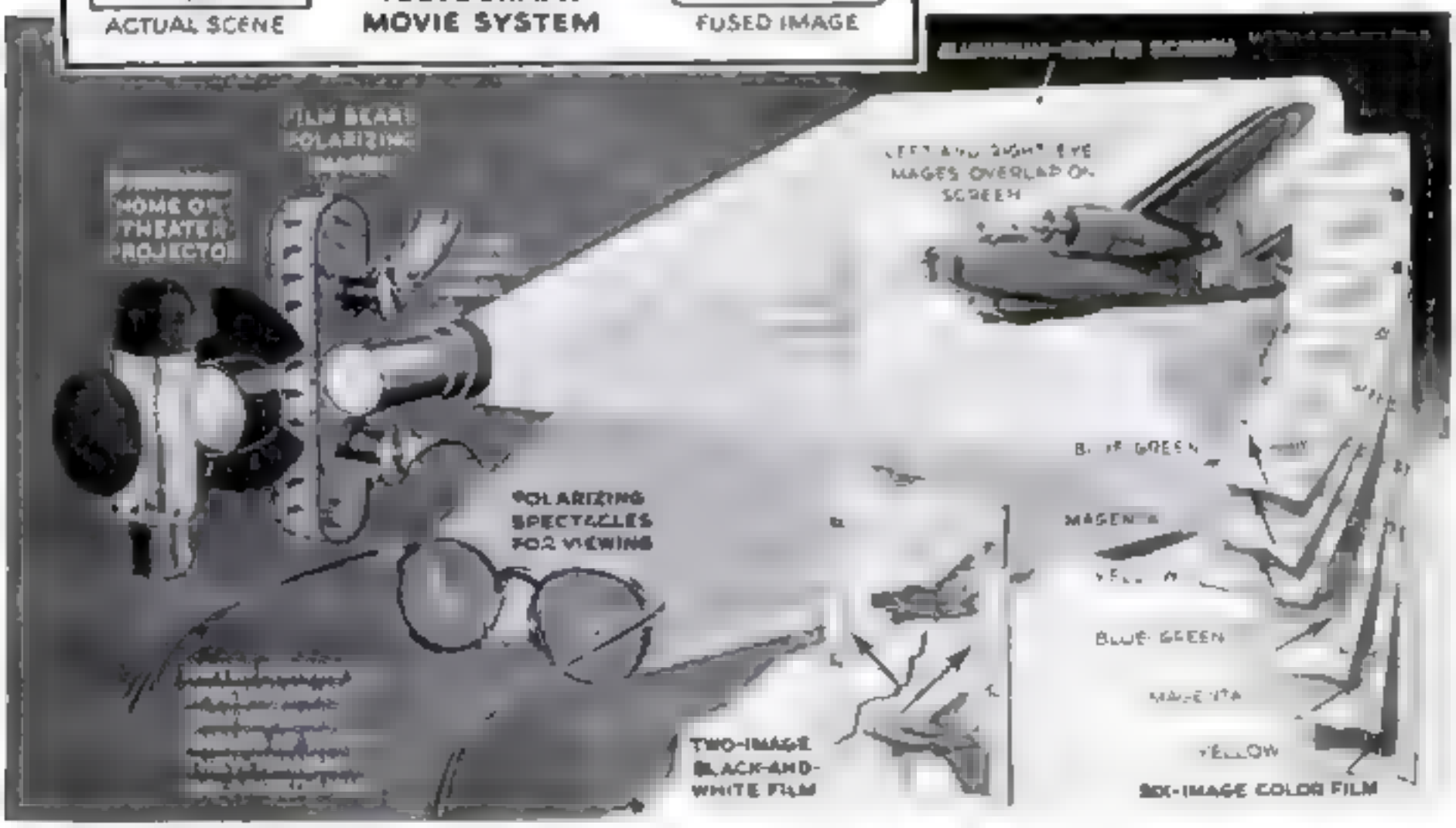
Ordinary prints from any of these photographs, mounted side by side, give a perfect effect of depth when viewed through an old-fashioned parlor stereoscope. But a soldier in the field has enough to carry without such cumbersome equipment. Therefore a special printing method is the first step of the Vectograph process. The negatives are printed photographically on pieces of special film. A "wash-off" bath takes the place of a fixing bath, transforming the picture from a silver image to a relief pattern of hardened gelatin. Its hills and hollows bear no direct relation to the contour of the terrain photographed, but rather to the distribution of high lights and shadows. For example, the relief print will be thickest where the finished picture should be dark.

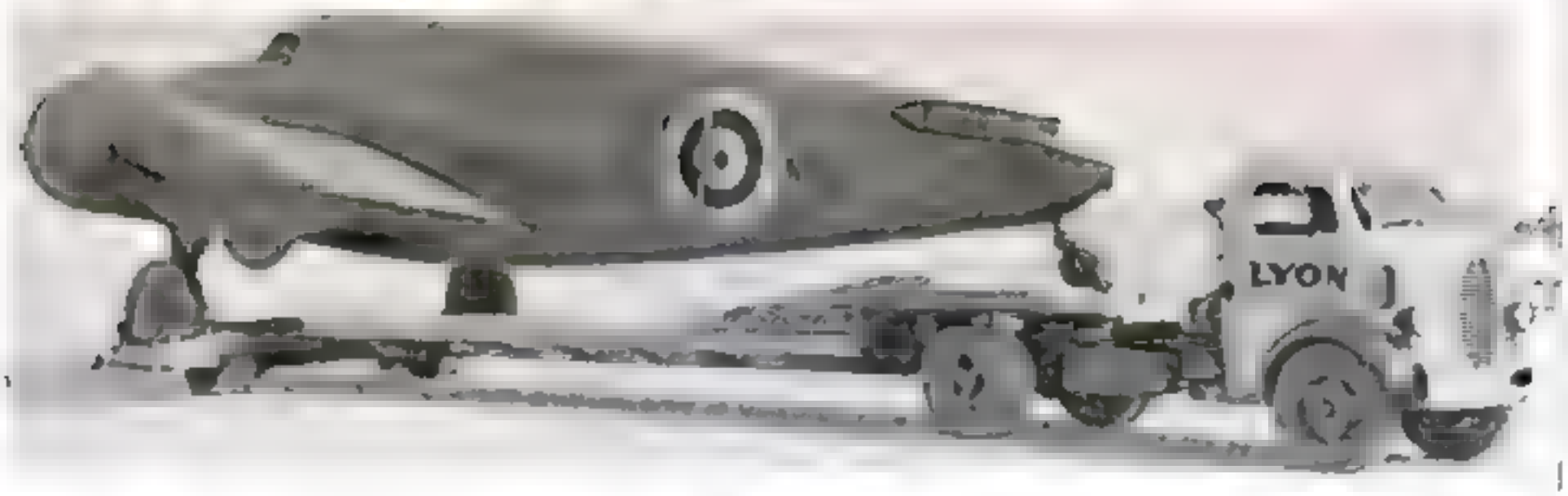
Now the operator carefully adjusts the relief prints so that the final Vectograph will have a double image, and then hinges them together. One of the negatives has been reversed in printing, and both relief images now face the inside of the "book."

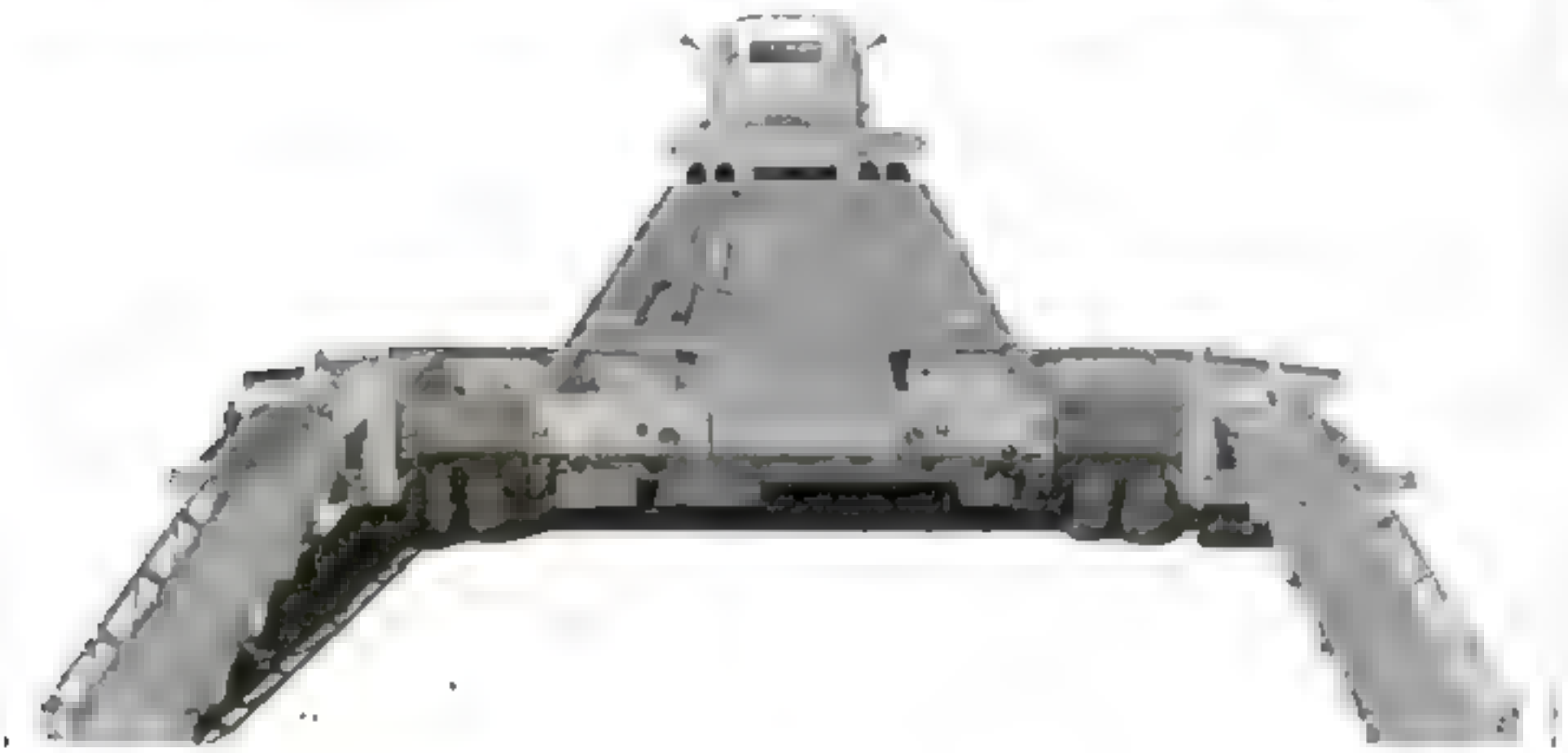
Placed in a brown chemical solu- *(Continued on page 212)*



The charts at left and below show the various optical principles involved in projecting color moving-picture Vectographs on the screen







TRUCK TRAILERS with telescoping axles are being used for hauling airplanes from factories to seaports and other shipping points. Axles can be extended to a width of 12 feet, and planes' landing wheels are run up bridgelike ramps to rest in special troughs. For the return trip, the axles are telescoped to eight-foot width to give road clearance for other vehicles. Another proposed use for trailers, illustrated below, is in rushing troops into action. Steplike platforms accommodate 206 fully equipped men, who can be unloaded and dispersed in 10 seconds. Such units are especially suited to moving troops in desert warfare.

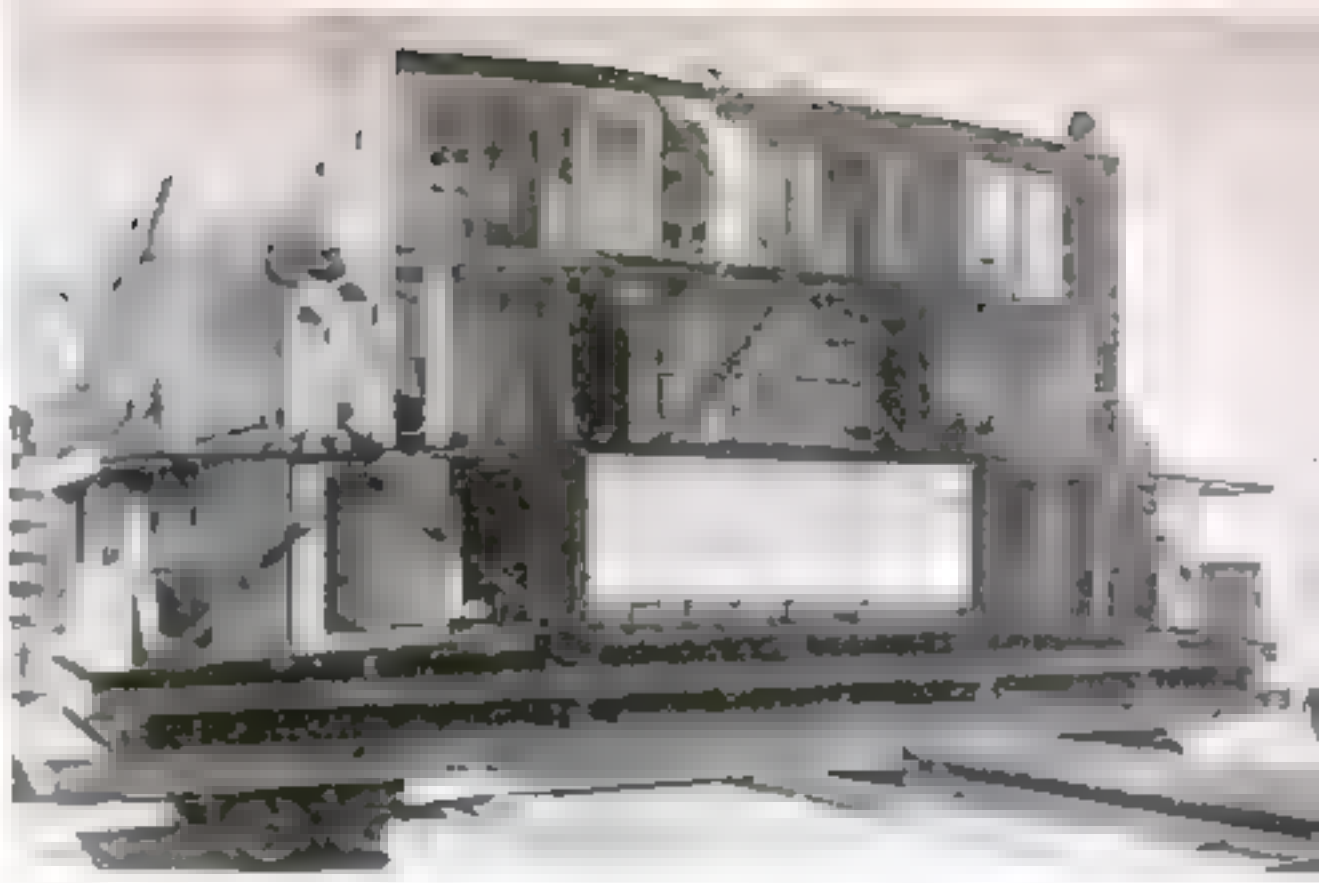
WAR

FLOATING FORTRESSES, similar to the artist's conception shown above, and designed to combat Axis aircraft, have been reported put into use by the Russian naval forces. Strongly equipped with antiaircraft guns and powerful searchlights, the floating behemoth is made of chrome steel, and has armor 11 inches thick. Because it lacks any means of self-propulsion, however, it is essentially a defensive weapon, and can be put to effective use only offshore from important military and industrial centers where it can intercept enemy planes intent on bombing or reconnaissance.

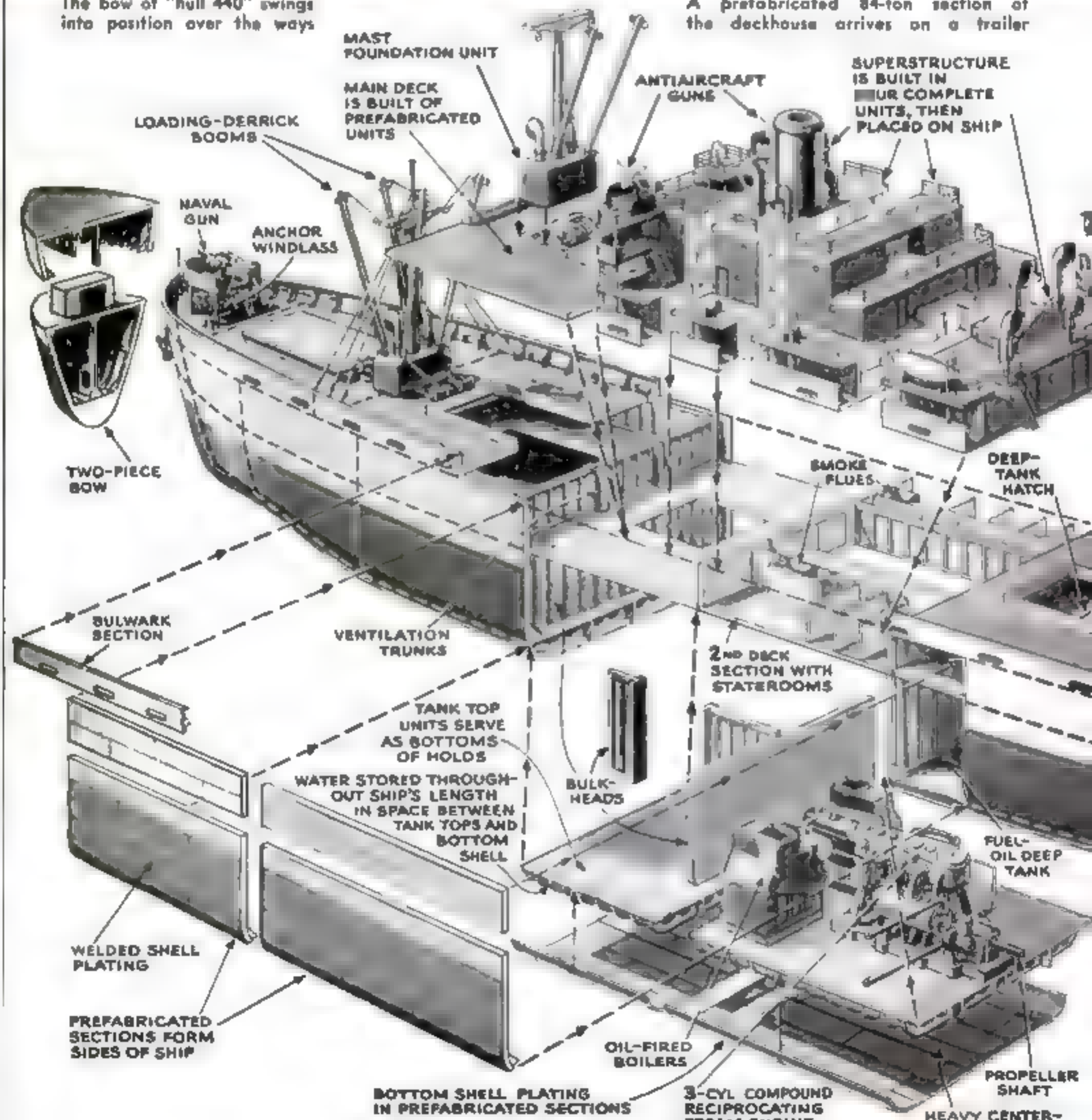
IDEAS

A WIRED ROCKET is the British Merchant Navy's latest surprise weapon to be used in fighting the Luftwaffe. Fired from a gun, the rocket carries into the air a parachute from which dangle long wires. By careful aiming and timing, gunners can drop a screen of these wires in front of enemy planes, which will cause them to swerve from bombing position or become entangled and destroyed. The parachutes remain in the air an appreciable length of time, and after they drop into the sea they can be salvaged and used again.

The bow of "hull 440" swings into position over the ways



A prefabricated 84-ton section of the deckhouse arrives on a trailer

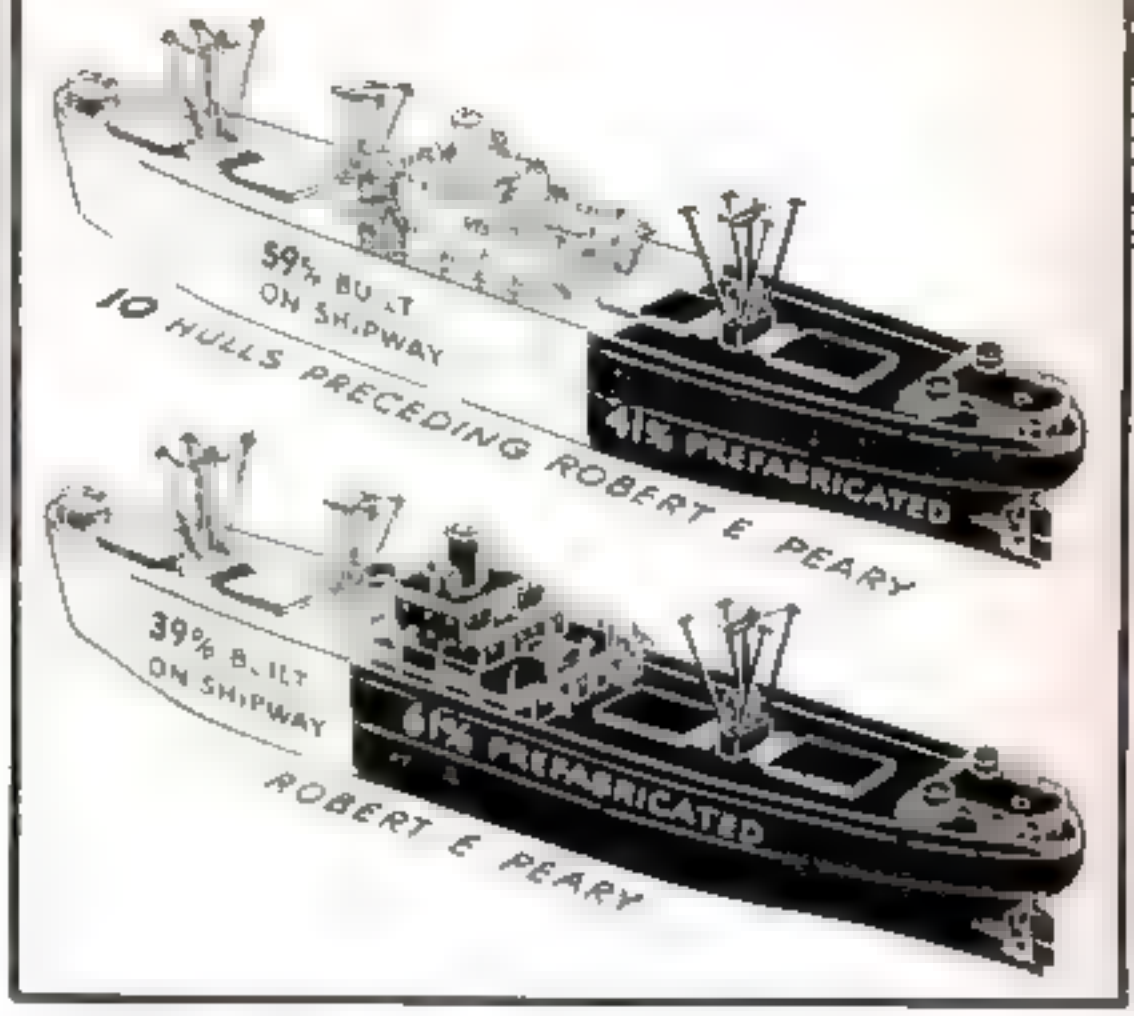


WHAT HAPPENS WHEN

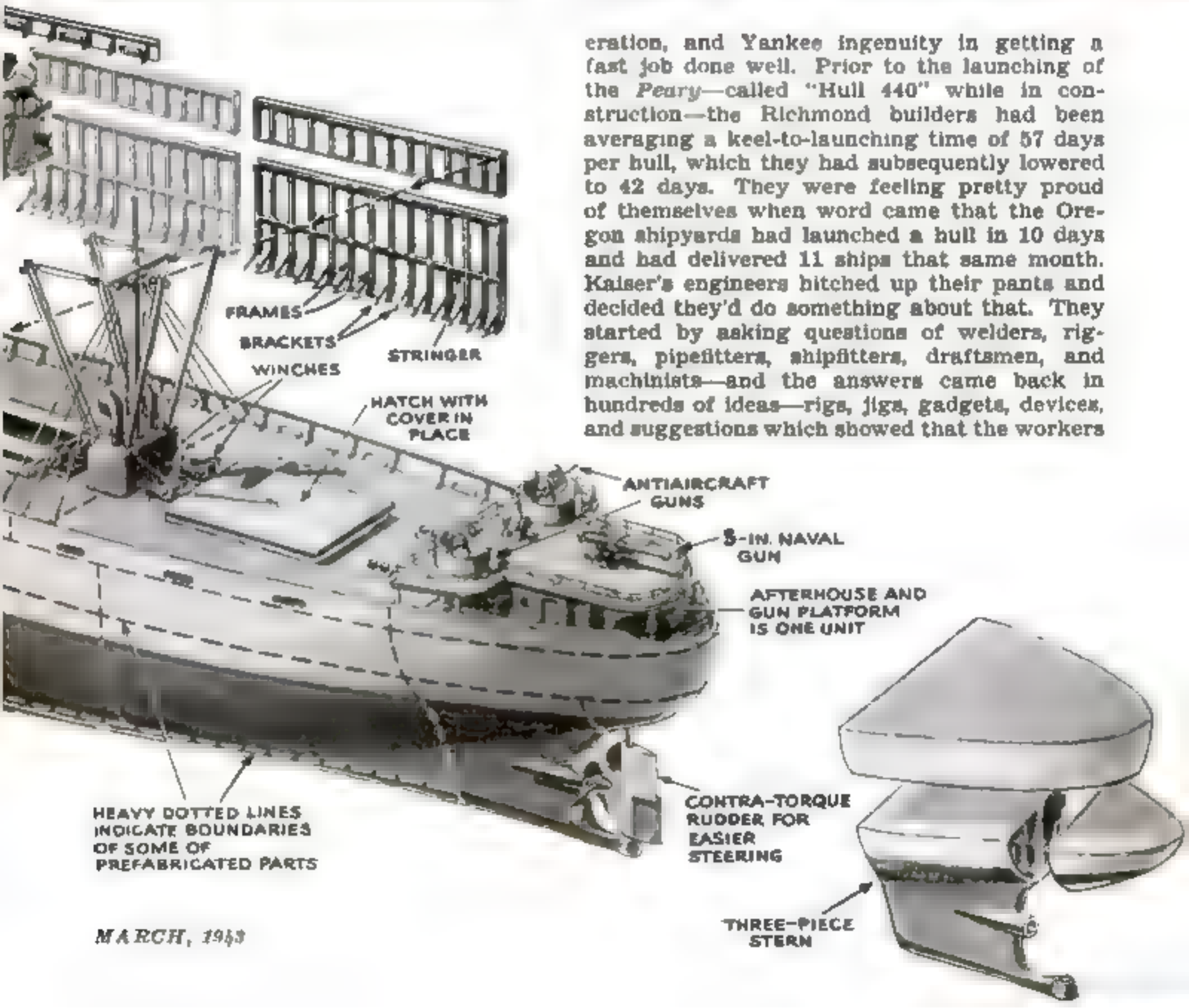
KAISER BUILDS A SHIP

A JIGSAW PUZZLE OF STEEL, WITH A QUARTER OF A MILLION PIECES AND 97 PREFABRICATED SECTIONS, FORMS A NEW VESSEL FOR VICTORY

DRAWINGS BY STEWART ROUSE



WHEN the 10,500-ton *Robert E Peary*, on November 12 1942, slid down way No. 1 of Henry J. Kaiser's Richmond shipyard after being on the ways only four days, 15 hours, and 26 minutes, it did more than set a world's record in speedy shipbuilding. It set records in pre-fabrication, labor-management co-operation, and Yankee ingenuity in getting a fast job done well. Prior to the launching of the *Peary*—called "Hull 440" while in construction—the Richmond builders had been averaging a keel-to-launching time of 57 days per hull, which they had subsequently lowered to 42 days. They were feeling pretty proud of themselves when word came that the Oregon shipyards had launched a hull in 10 days and had delivered 11 ships that same month. Kaiser's engineers hitched up their pants and decided they'd do something about that. They started by asking questions of welders, riggers, pipefitters, shipfitters, draftsmen, and machinists—and the answers came back in hundreds of ideas—rigs, jigs, gadgets, devices, and suggestions which showed that the workers

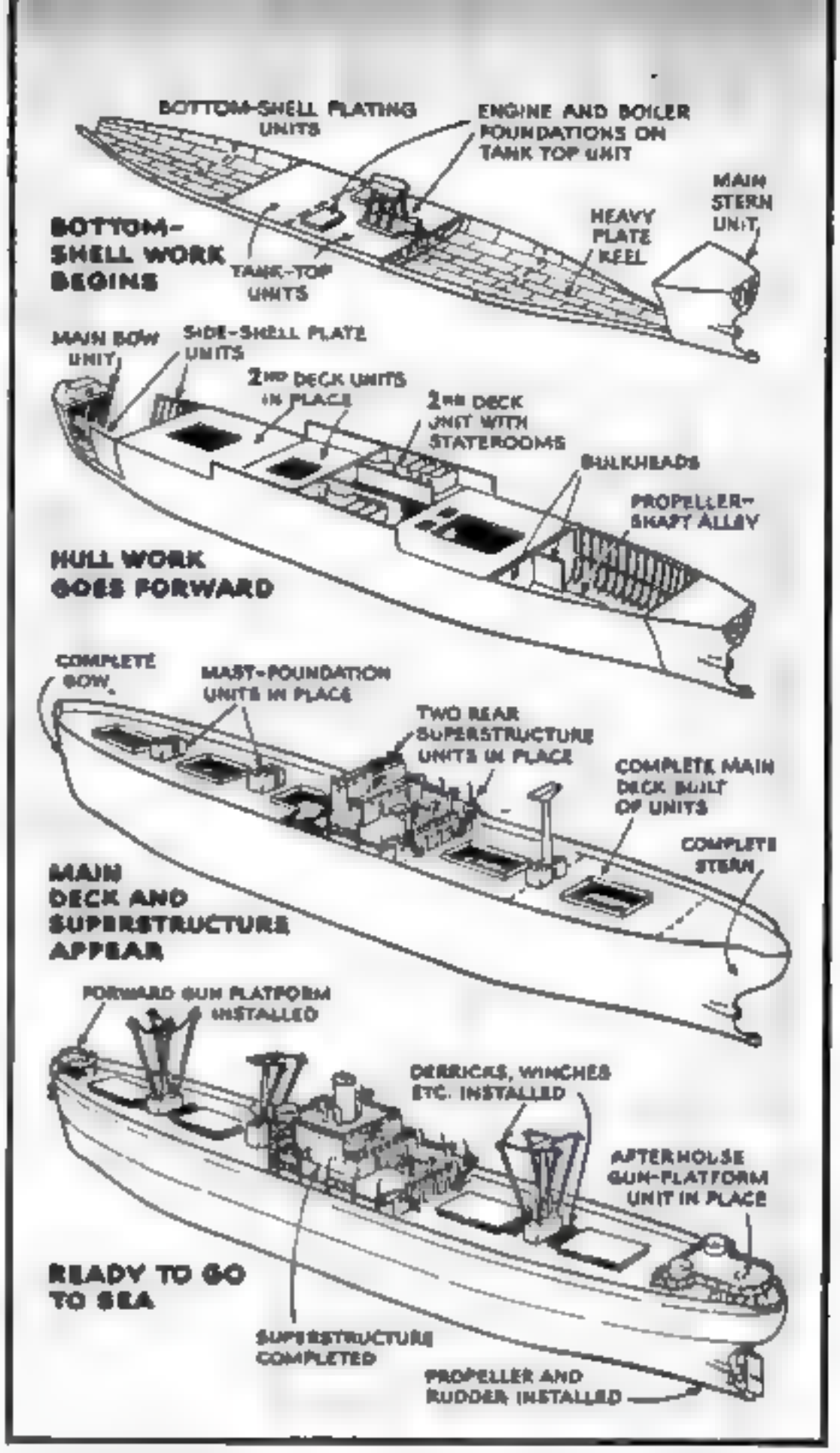


not only knew their business but that they were willing to work for a new record. Take the welders, for instance. When volunteers were called for, a dozen women welders threatened to quit unless they were included. They and dozens of men went to work with arcs blazing, and by the time the hull was laid, 152,000 feet of weld had been completed on the assembly tables—50,000 more than on previous hulls—and only 57,800 remained to be welded on the ways. Riggers then found they had fewer lifts to make because prefabricated sections were more complete. So they set about saving hundreds of man-hours by moving 84-ton deckhouses and 70-ton bulkheads nearer the ways to have them right at hand the instant they were needed. Prefabrication reached such a high that when the main unit of the 440's deckhouse was swung into place with giant cranes, it was complete down to electric clocks and inkwells.

Approximately 250,000 individual items went into the building of Hull 440. But by the time the prefabrication boys had finished their work on the assembly tables, only 97 giant sections needed to be lifted on to the ways. The huge keel called for the laying of merely six main sections. Eighty percent of the 23,095 rivets used were driven home on the assembly tables. And on the bilge and forepeak, 18 gangs of five men each worked 'round the clock to finish their job before the keel was laid.

The marine machinists did their job, too. They had the 135-ton engine in place 12 hours after the keel was down, and in another 36 hours they had it ready to run.

Before shipyard workers can do their job, they must have the materials—and they must have 'em when they need 'em. To insure that they get them, Kaiser employs a staff of what he calls expediters. Ingenious, resourceful, and aggressive, these energetic men scamper all over the country, busting bottlenecks wide open as they run. It is this kind of teamwork that has reduced shipbuilding time from years to days.



Named for the famous American explorer, the *Peary* is a 10,500-ton vessel with an over-all length of 441 feet. In building this prefabricated ship, the slogan of the workers was "Praise the Lord—and pass another section"

How the Gandrillon plan would supply electric power to the Holy Land. The topographical map shows the mountainous country between the Mediterranean and the Jordan. Below it is a sketch of the elevation, and to the right a scale map

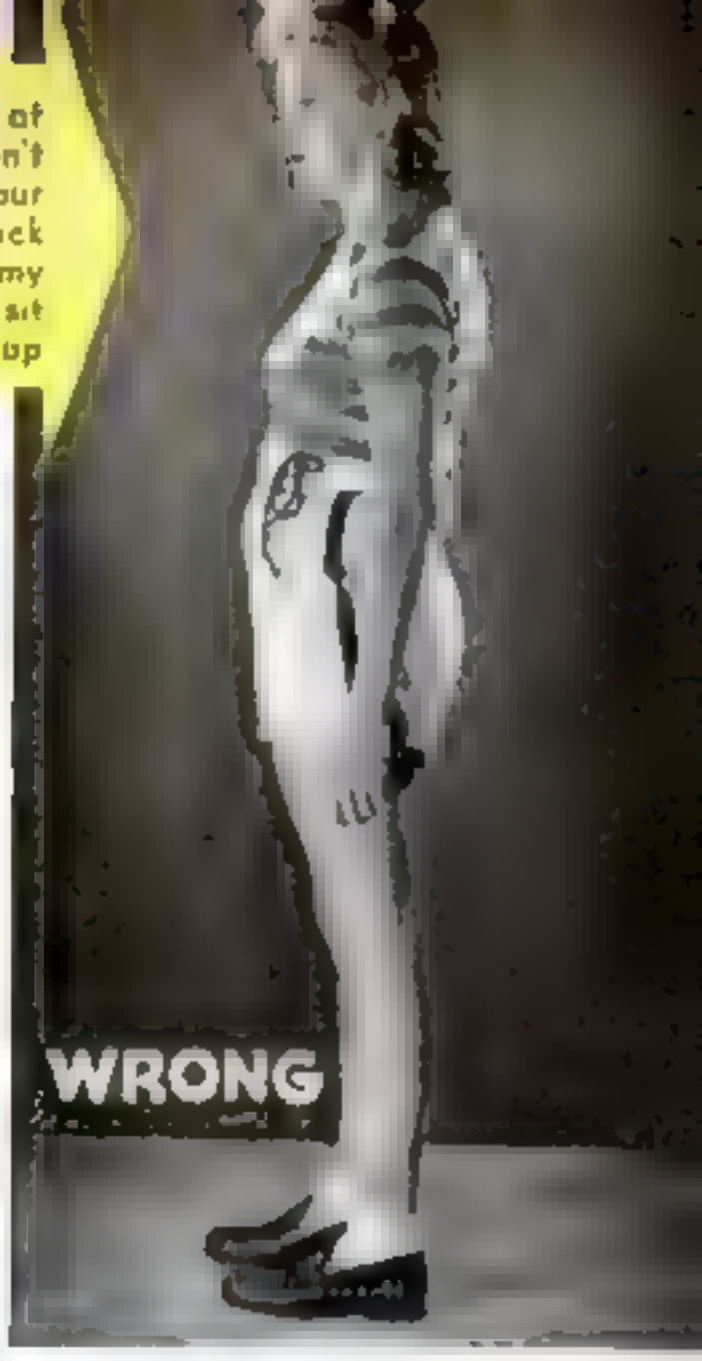
Power Houses Below the Sea

DOWN the Valley of the Jordan, after the war, there may flow water from the Mediterranean to supply electric power for life and industry in the resettled land of the Bible. That is the plan of Pierre Gandrillon, a French scientist and engineer, who had completed his work to the point of actual survey when the war intervened.

Water pumped from the Mediterranean to a reservoir near the Sea of Galilee would drop to the valley and a generating plant which would provide power in excess of that needed for pumping. A navigable canal paralleling the Jordan would carry the overflow to another power plant at the edge of the Dead Sea, where rapid evaporation would care for the surplus. A dam also at the Sea of Galilee would divert its waters for irrigating the surrounding country.

For that nagging kink in your back, try a "cat stretch." Raise your arms above your head, keep them apart, arch your back—then reach for all you're worth

If you stand at your job, don't droop. Hold your shoulders back and your tummy in. To rest, sit with your feet up



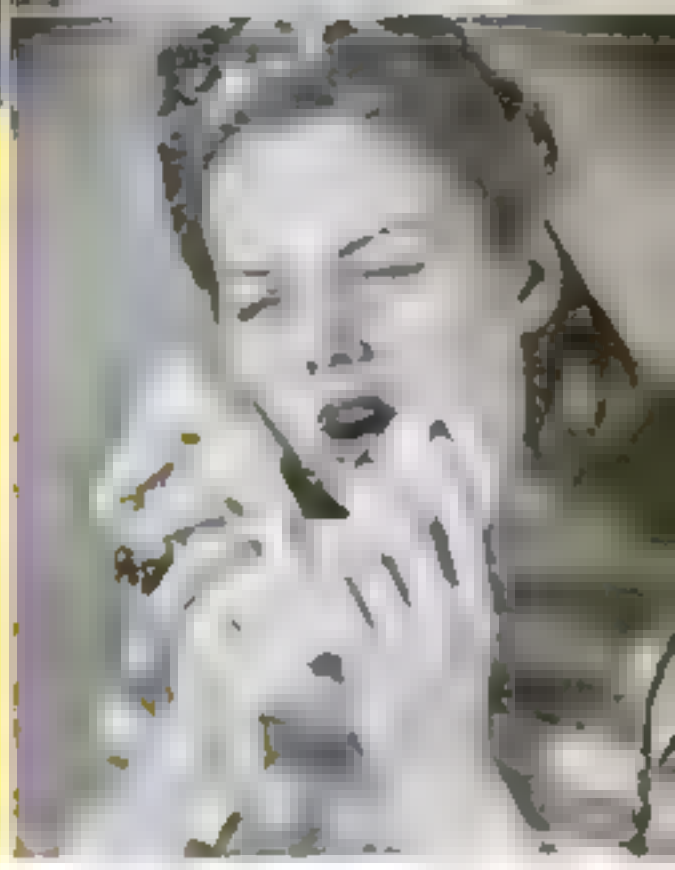
EXERCISING

Muscles as Well as Minds Are Being Put to the Test in U. S. Plants. Here Are a Few Tips to Help Banish That War-Worker Weariness

TIRED FEET need soaking in warm water roomy flat-heeled shoes and one minute of toe wiggling with heels higher than the hips

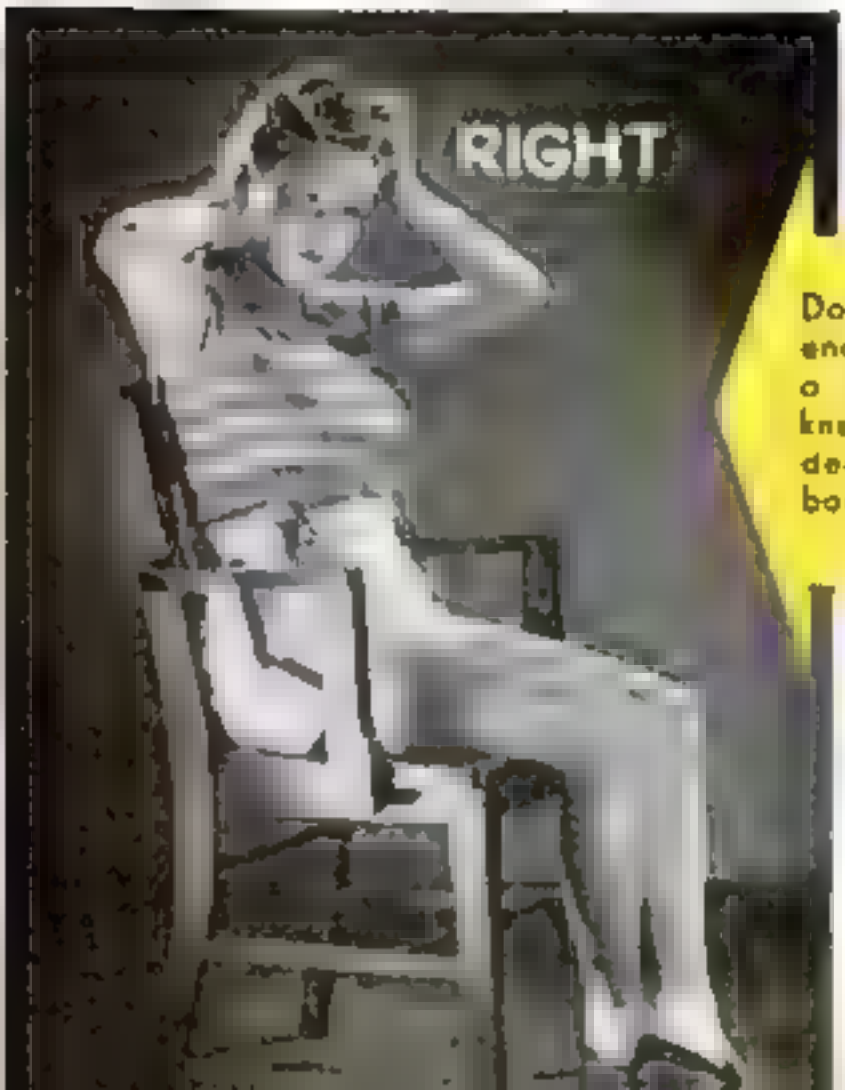
CRAMPED HANDS can be relaxed by being scrubbed in water, by massage or by just a good hand shaking

SNEEZES belong behind a handkerchief First line of defense against a cold is cleanliness For a fever go to bed—and stay there



HEALTH TRICKS FOR WAR WORKERS

OF THE millions of men and women in U S war plants, many are "green" to hard physical labor, and most are learning for the first time the agony of muscle strain. As critical as the materials they are making, however, is the ability of these operatives to keep working long hours, day after day, without loss of efficiency. Intensive research by the U S Department of Labor and various safety councils discloses that brief, regular rest periods from a machine or workbench are the surest safeguard against the fatigue which invites both accident and inefficiency Also strongly recommended are the simple muscle-rejuvenating exercises shown on these pages.



Don t perch on the end of a chair n a slumped knock kneed fashion Sit deep with backbone against chair

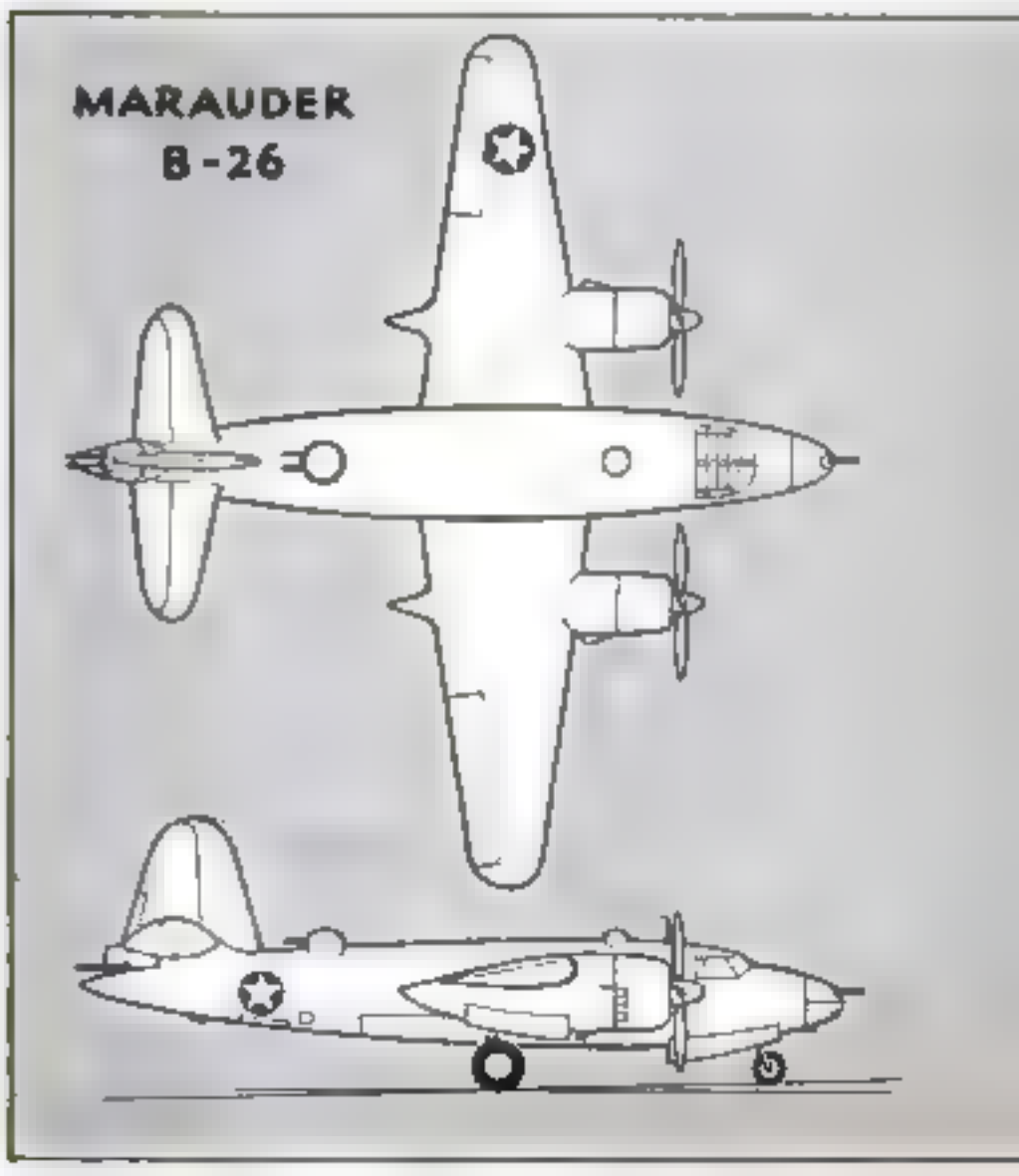
Believe it or not, one of the best ways to revive tired muscles is to exercise them in a speedy game

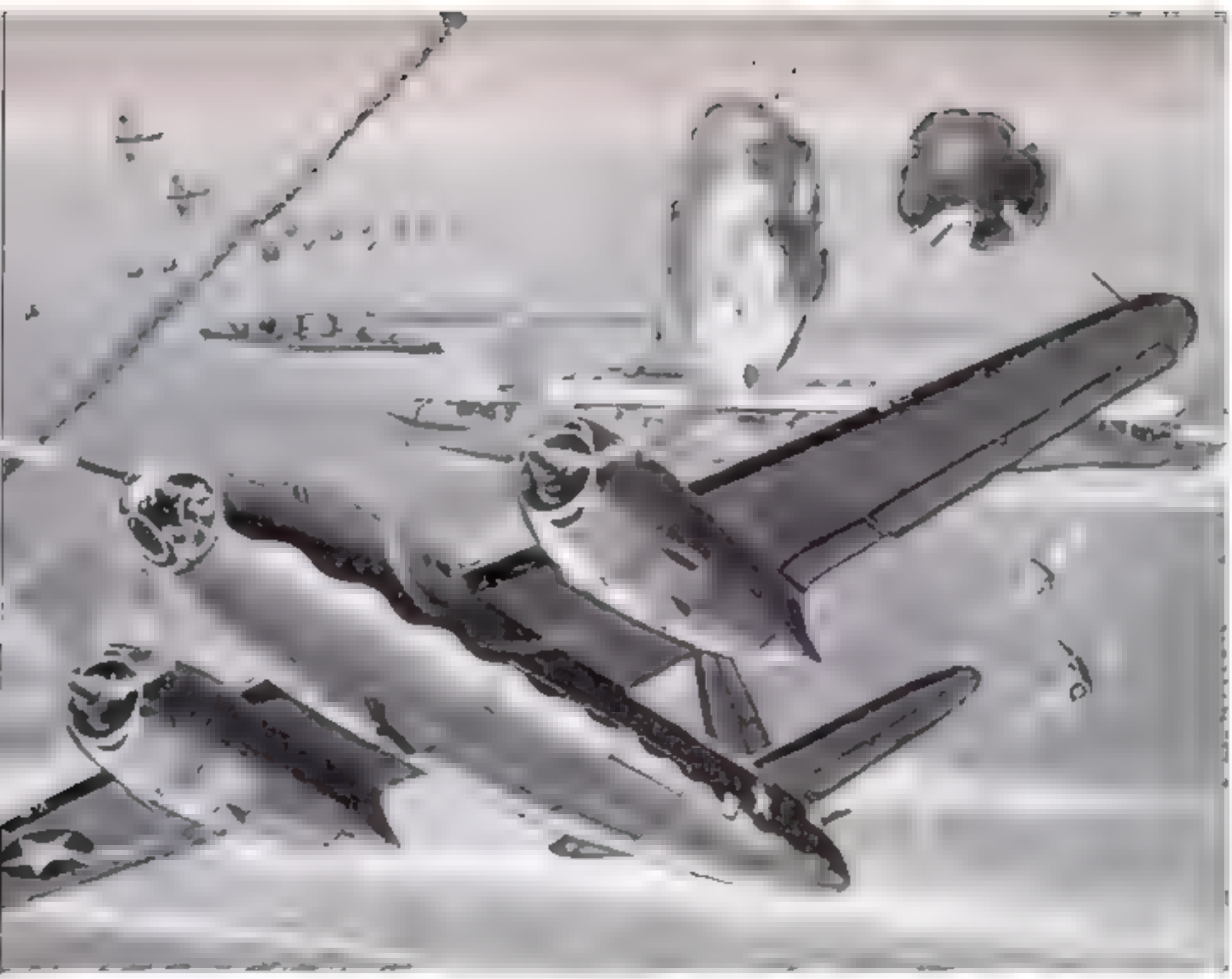
In the B-26, the Army has found what it has long looked for—a bomber that can fight through to an objective and then fight its way back. Although it now carries heavier loads than it was originally designed for the Marauder still flies like a racer and maneuvers like a fighter

THE ARMY ASKED FOR A MIRACLE... THE ANSWER WAS

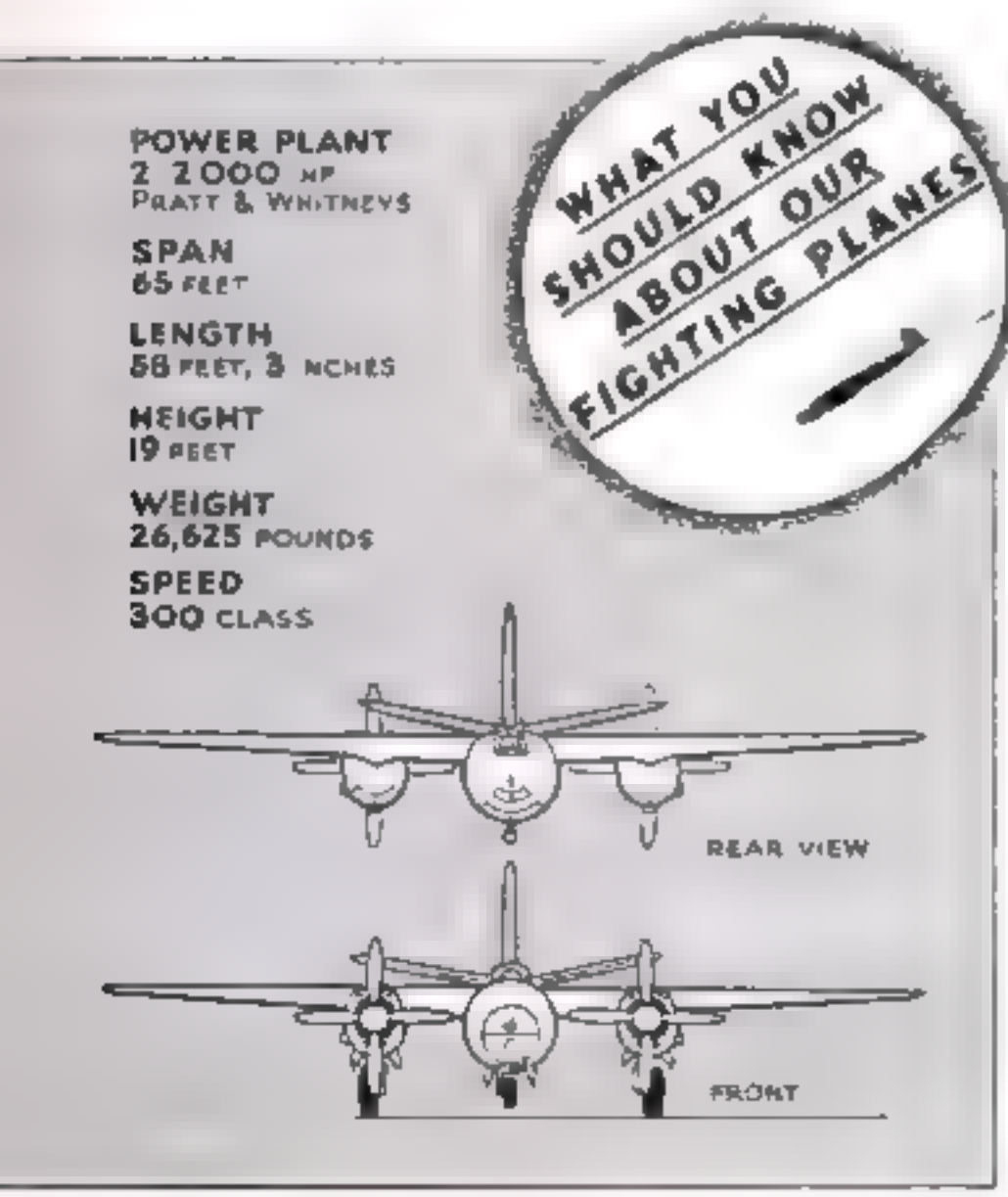
The B-26

HOW GLENN L. MARTIN BUILT A MEDIUM BOMBER THAT FLIES LIKE A CLOSED-COURSE RACER





The Battle of Midway turned out to be a proving ground for the torpedo-carrying Marauder—and a burial ground for Jap warships. When the battle started, a formation of Jap carriers, powerfully escorted, was attacked by four B-26's. The score was two carriers sunk, two Marauders lost



By William S. Friedman

IF THE Japanese have not developed any profanity in their language in 2,000 years, they must be thinking up some at this late date to describe the U. S. Army's B-26 medium bomber

On this side of the Pacific, no well-informed observer has offered a temperate opinion of this airplane. It has either fast friends or outspoken critics. But there is no doubt that the B-26 is the fastest, fightingest, most ornery twin-engined medium bomber produced to date. It flies at near-pursuit speed, turns like a fighter, and has a tricycle landing gear that allows it to operate from bases usually staked out for fighter planes.

The B-26 had a swift, almost tumultuous beginning. Shortly before the march on Poland, the major planners of American war strategy saw that we might have to fight beyond the seas. Before this time, the belief that we could operate from our own hemisphere had produced the Flying Fortress and similar long-range craft. Events in 1939 dictated a radical change in that policy. To supplement the Boeing B-17's, a fast, shorter-range bomber, capable of sinking a battleship should it slip inside the long-range patrol, seemed to be required. The original theory was that if such a bomber was extremely fast, it could get away with light defensive armament, depending on high speed for its own protec-

tion against the enemy fighter opposition.

The bid for an airplane of this type went out to the nation's manufacturers. The Glenn L. Martin Company in Baltimore took the proposition under consideration and asked the engineering staff to submit proposals in the form of three-view drawings. Several sets of sketches were sent in. They were set up for study and discussion before the entire staff. Then iron-haired, steel-eyed Glenn L. Martin walked in, surveyed the half-dozen proposals and, after a couple of minutes, pointed to one. "That's it!" He picked out a proposal set forward by the brilliant nonconformist, Peyton Magruder.

Some of the engineers who studied the Army's demands had asked, "When do they want this miracle passed?" The general opinion, at first, was that the Army was asking for the impossible. That was all that was needed. It seems that the Army's current motto, "The difficult performed immediately, the impossible takes a little longer," started with Magruder and the specialists who worked with him.

Most men would have gone about picking up where their predecessors left off. Magruder heaved most current ideas for bomber design out the door, welcoming such notions as all-plastic transparent noses, and streamlined fuselages that simulated theoretical blackboard illustrations. He drew as perfect a set of outer contours for speed and performance as anyone dared in a ship that size, then defied the structures men to design for his theory.

For three weeks the project engineers lived within the limits of the Martin plant near Baltimore, driving a drafting crew to the verge of collapse as events in Europe showed more and more the desperate need for this kind of airplane—a ship that could fly like a racer, maneuver like a fighter, and lift a truck's load.

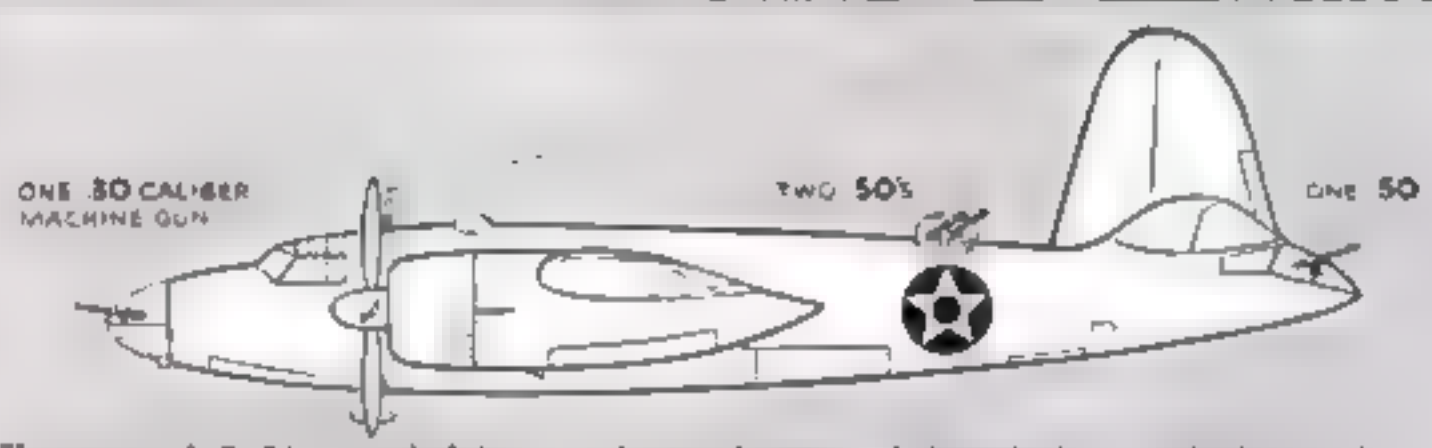
The proposed bomber was exactly what most people thought Magruder would trot out. Short-spanned, high-winged and deep-bellied, a closed-course racer built big, packed with the latest radical ideas on airplane design.

There was no fussing about peacetime production frippery. The first B-26 that came off the line was the pilot model and full-scale prototype in one. Behind it stretched a production line. The B-26 represented the longest chance ever taken on a single design.

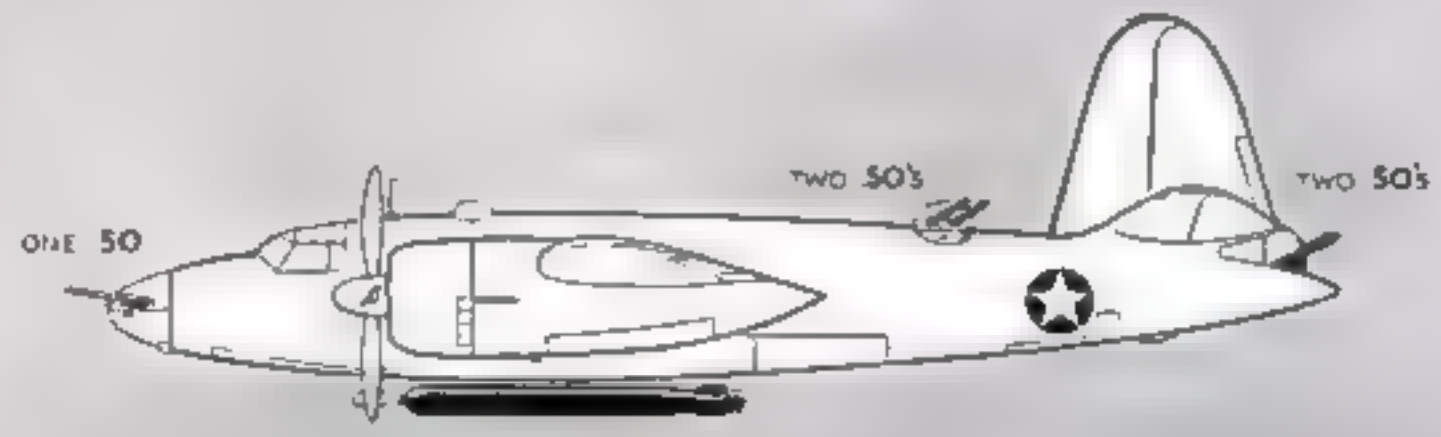
The first Marauder appeared in November 1940. It had a span of 65 feet, was 58'3" long, and was powered by two 1,850-h.p. Pratt & Whitney Wasp engines. Its top speed was above 350 m.p.h. The prototype, unburdened with armament, had an operating ceiling in the neighborhood of 29,000 feet, and its range ran just a little short of 2,400 miles. With current armament, the range is approximately 1,300 miles.

The early models were lightly armed. They toted a .30 *(Continued on page 75)*

HOW THE FIRE POWER OF THE B-26 HAS BEEN STEPPED UP



The original B-26 was lightly armed. Its designers believed that its high speed made heavy defensive armament unnecessary. War experience brought a change



to the heavily armed Marauder of today. Other guns may be added to those shown here. A torpedo can be carried in a simple rack on the underside of the fuselage

FROM the big transparent nose of the Martin Marauder, the bombardier aims the .50 caliber machine gun that guards the bomber from head-on attack. (Kodachrome by Hans Groenhoff)

Short-spanned, high-winged, and deep-bellied, the B-26 is designed to fly like a fighter—and haul bombs by the truckload

Two .50's in the tail give the Marauder a murderous sting. The first, lightly-gunned B-26 had only a single gun in this spot

In its specifications for the B-26, the Army seemed to ask for the impossible—and got it. Defying most of the orthodox ideas of warplane design, the Marauder was one of the longest chances in aircraft building

caliber machine gun forward and a heavier one in a light mount in the tail, while the main weight was borne by the two .50s in a top power-driven turret.

The day the first Marauder taxied down the line at Martin's plant, everybody knew it was going to be plenty hot—and it was. The ship caught up with a couple of contemporary first-line fighters. Its top speed was so great that good air pictures had to wait until a second model could be built. Only a few ships could pull up alongside to give a photographer a chance for a shot.

There is more to the simple, clean, cigar-shaped lines of the B-26 than meets the eye. Probably this was one of the things that sold the production-wise engineers like Harry Volmer, the manufacturing boss, and factory manager Tommy Soden. The fuselage was unusually free from compound curves which are tough to make, tougher to tool and all but impossible to assemble. The ship had been engineered to eliminate one of the major bugbears of airframe production.

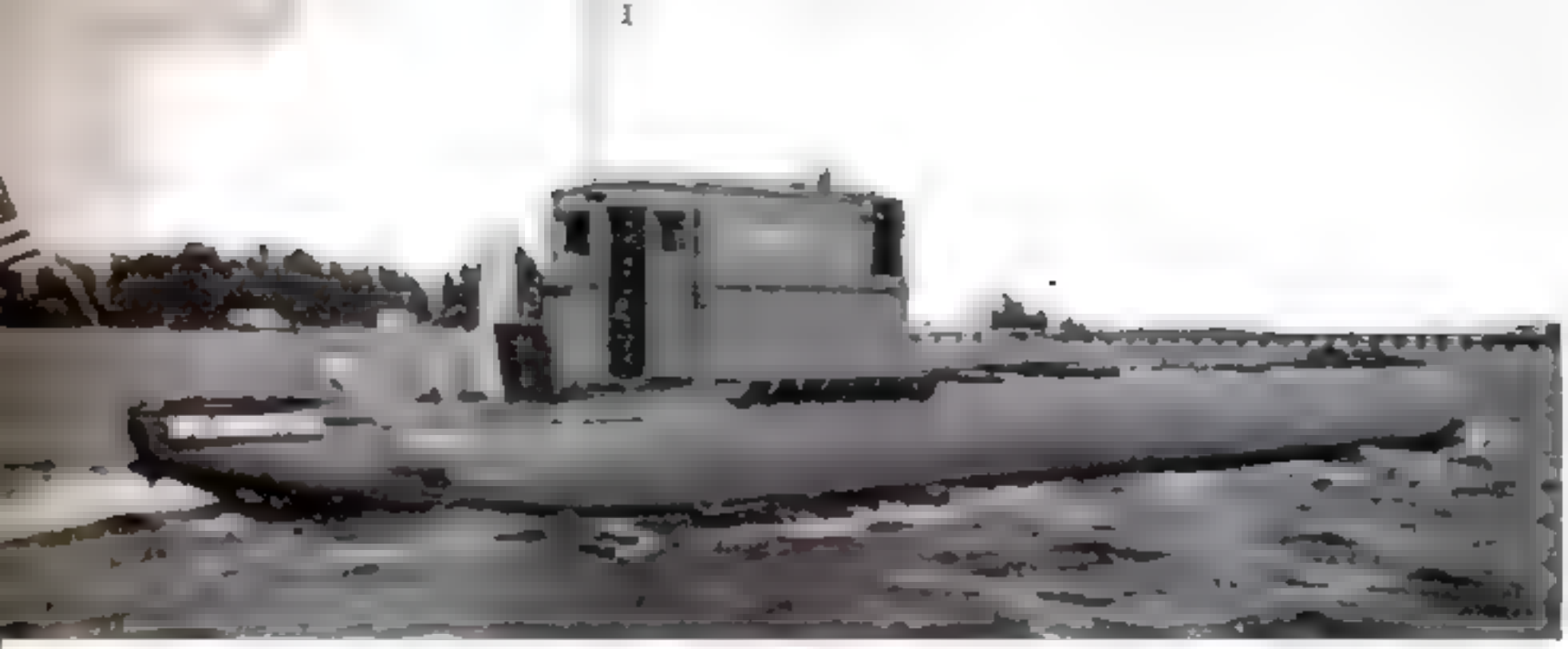
As more and more war information rolled in, it became evident that even a medium bomber must take care of itself in a fight, and that, despite high speeds, the effectiveness of a bomber depended on how well it could fight its way to an objective and fight its way back. More guns went onto the Marauder. The single-gun stinger in the tail gave way to two .50's. The .30 caliber peashooter that protruded delicately through the transparent nose was replaced by a murderous flexible .50.

Most recent addition to the ship's armament is a simple rack that permits it to sling a torpedo outside. The first appearance of this idea at the Battle of Midway, major proving ground for the B-26, was a complete surprise to the Japanese fleet. A formation of aircraft carriers was approaching Midway, surrounded by destroyer and cruiser escort. The plan was for high-flying B-17's to "soften up" the enemy, while the B-26's swept in for the kill. Everything was OK except that the Fortresses failed to make contact with the enemy. As a result, when the four B-26's came in flying low, they were faced with a completely screened naval unit, still keeping perfect formation. There was no waiting, no turning back. The Japs stood by for a low-flying bomb attack, spreading formation to minimize hits. The B-26's, taking advantage of their maneuverability and speed, dropped close to the water for the attack. This meant that precious time was gained as the Jap antiaircraft gunners had to readjust their gun positions. The B-26's dashed in and delivered their deadly missiles, sinking two of the carriers right in the middle of the defense formation.

Performance in the Aleutians, where they sank two destroyers in one patrol, indicates the great advantage gained by long-range torpedo patrol. The maximum range for the best regular torpedo plane is in the neighborhood of 1,000 miles. This means that patrol activities must be limited to small areas or entrusted to slower equipment. A plane like the Marauder can carry its torpedo considerably farther, searching inlets and protected water where enemy craft may be lurking.

One remarkable thing must be noted in the Marauder's performance: It is little affected by the increased loads imposed on it. Guns, bombs, and torpedo can be saddled on it. Still the Marauder lifts its nose up, tucks away its tricycle landing gear, and soars away.

By orthodox engineering ideas, the Marauder should not even taxi. The authoritative German magazine, *Luftfahrtforschung* originally passed the design off as a joke. The Japanese official registry would not even list it. Some folks are still in doubt, rubbing their eyes as production-type B-26s go off the line to make things unpleasant for Berlin and Tokyo.



The *Phantom*, 91-foot model of a radio-controlled concrete convoy vessel proposed as an answer to the U-boats. The cabin is a temporary structure for the crew of two that took her to Washington for tests

Crewless Ships for Phantom Convoy

RIDING at anchor in the Capitol Yacht Basin at Washington is one of the strangest ships afloat. Appropriately named the *Phantom*, she resembles anything but a sea-going craft. Her deck is almost flush with the water line. Missing are smoke-stacks, superstructure, and cabins.

The *Phantom* is a 91-foot model of a revolutionary-type concrete ship, completely automatic and designed to travel in convoys of ten or more operated by remote radio control. In convoy the crewless ships are expected to slip through the water at 10 knots, invisible to enemy raiders beyond a radius of two miles. Progress will be controlled by an escorting vessel using a secret system of ultrashort-wave and code-signal devices. If the control vessel is sunk, the Phantoms will proceed for two hours on the same course. Then mechanisms aboard will halt them automatically and send distress signals, giving their approximate position.

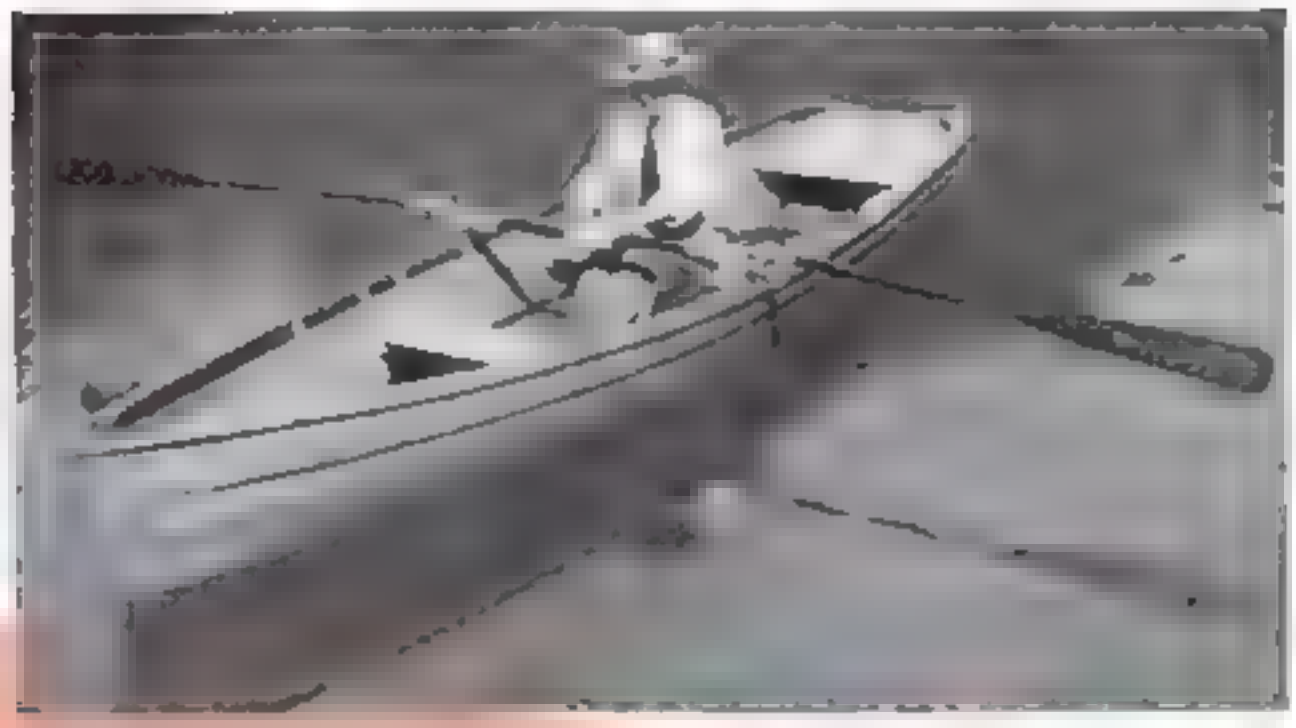
The Phantoms are to be 260 feet long, 36 feet on the beam, and 27 feet deep—small for modern shipping—but they will have a dead-weight capacity of 2,000 tons. Diesel engines of 1,000 horsepower will drive them under automatic control. Except for air intakes for the engines, the craft will be completely sealed.

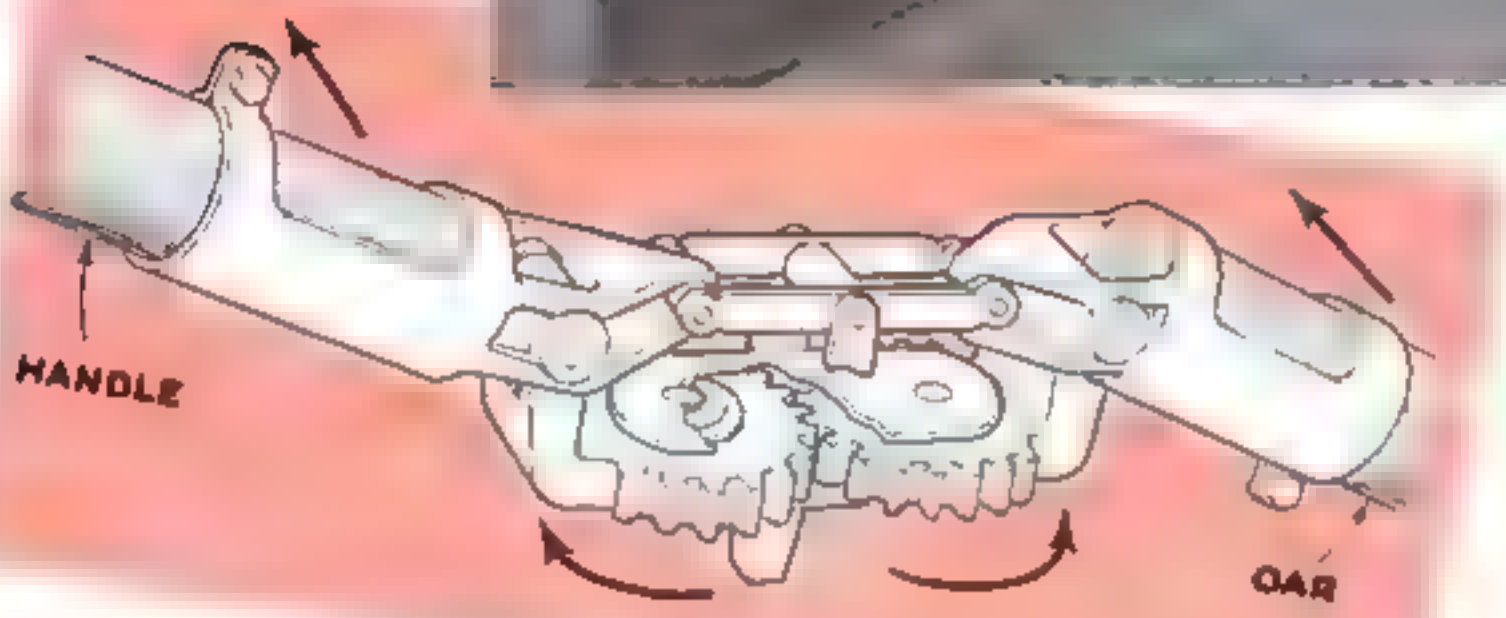
A series of 10 to 15 watertight compartments will make a Phantom fairly resistant to torpedo attack. If a torpedo hit floods one of these compartments, ballast tanks with automatic pumps will trim the ship. All vital parts will be concentrated within a space less than a tenth of the ship's total length.

Into this ingenious plan have gone the skill of F. B. Woodworth, radio expert who helped develop ship-to-shore radiotelephone service, and Vladimir Yourkevitch, designer of the *Normandie's* hull. Their model, the *Phantom*, is awaiting Government tests. They believe that Phantom convoys will save the lives of many merchant seamen and help solve United Nations shipping problems.

The model receives her appropriate name in the launching ceremony at a Florida shipyard. Actual ships would be 260 feet long and 36 feet in the beam. A convoy of these vessels, controlled by a "mother" naval craft, would be almost invulnerable to torpedo attack

Reverse Oars Let Rowers Look Ahead





The inventor demonstrates use of the "see-where-you're-going" oar. Details in drawing

ROWING a boat while facing forward is said to be made practical for the first time by an invention of Percy M. Griffin, of Albany, N. Y. The device consists of an oarlock in which the forward-and-backward motion of the oar handle is reversed in the oar by means of segment gears as shown in the drawing above. At the same time, a rocker mechanism controls the vertical movement so that the oar is lifted out of the water when the handle is depressed, as in ordinary rowing. The complete oar with its mechanism lifts out of the socket and can be folded for carrying and storage. Detachable sockets are provided so that the device may be used on any boat.

"HURRY HUTS" built entirely from prefabricated wood sections are protecting U. S. troops from the rigors of winter in Alaska and on the Pacific Coast. Containing no metal except the bolts and a few fittings that hold them together, they represent a saving of at least three tons of steel for each unit as compared with steel huts. Only 39 man-hours of labor are required to erect one of the huts, and inexperienced workmen may be employed. Packaging is carefully planned to eliminate loose parts as far as possible, with bolts embedded in section panels and nuts attached.

HOW SCIENCE IS

Changing Your Clothes

YOUR clothes are due for a lot of changes, and you will like them all. You'll soon be wearing suits made partly out of skim milk, soybeans, peanuts, seaweed, bark, cellulose, plastics, and possibly even glass, and you won't even have to get used to it. The chances are, if your merchant didn't let you in on the secret you'd think you were still buying wool.

This is the day of synthetics—and in textiles as well as in other fields, the chemist is going to give you good substitutes for the materials you can no longer buy. If sheep can't grow enough wool to clothe both you and the Army, the chemist will take the food the sheep eat and grow wool in his test tube without the need and the delay of the middleman. Samples of the magic show that the venture is a great success.

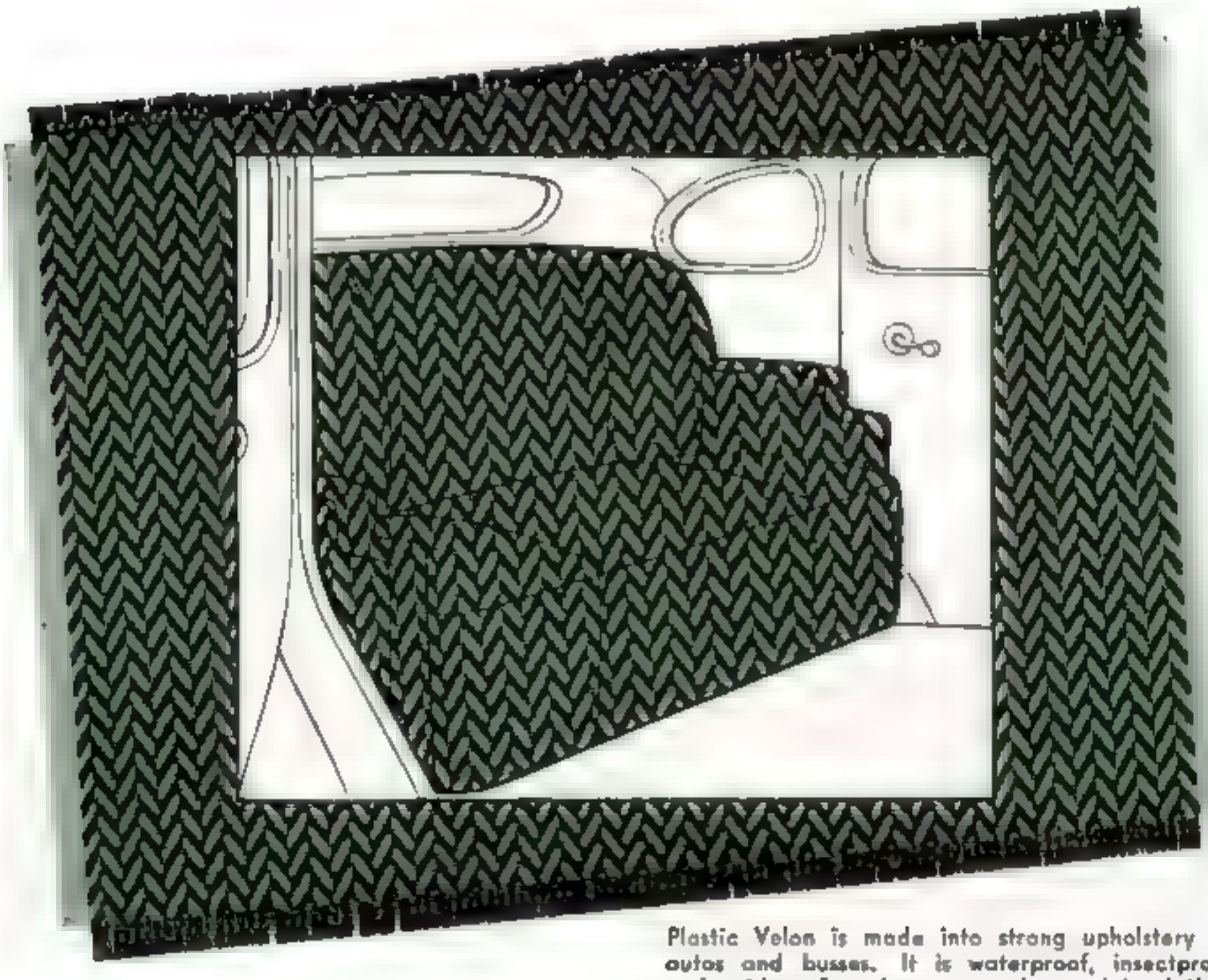
There is cloth for suitings and overcoats made partly of rayon from cotton linters, Aralac processed from skim milk, Palco shredded from the bark of the redwood tree, and peanut fiber from the peanut kernel. Velon, which is a plastic, and soybeans are going into handsome, serviceable upholstery. Nylon scraps left from the manufacture of parachutes are used in other war materials. Fiberglas yarns are making colorful neckties, draperies, and bedspreads. Most of them can duplicate all the qualities of natural fabrics, and many can add something extra.

Scientifically, man-made fibers fall into four major classes: protein, which is a component of food; cellulosic, from cotton and wood pulp; true synthetics, from coal and air; and glass. Aralac, first of the usable

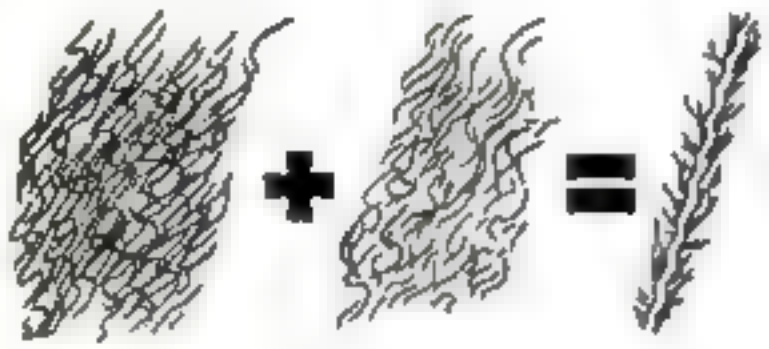
protein fibers to be introduced, is derived from casein, which is about three percent of the content of skim milk. One National Dairy Products Corporation factory is producing about 5,000,000 pounds of Aralac yarns this year and, blended with fur or wool, the synthetic has already met wide acceptance in "felt" hats. It has turned up also as a blend with rayon, giving that cellulose fiber a woollike resilience. Aralac is like wool in every way, but is only about 75 percent as strong and needs a blend to make it wear.

Henry Ford is producing a soybean protein fiber on a commercial scale (P S.M., Aug. '42, p. 106). It has been used mostly in wool blends for upholstery materials, but successful experiments are being made in developing a

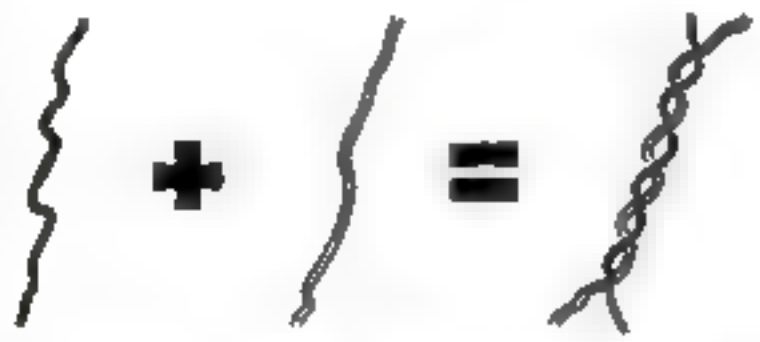
Extrusion is the essential process by which most synthetics are converted into textile fibers. Reduced to viscous liquids, they are forced through tiny holes in a nozzle, or spinneret, into a coagulating bath, emerging as fine filaments. Some are woven as continuous filaments, others chopped and spun into staple yarns



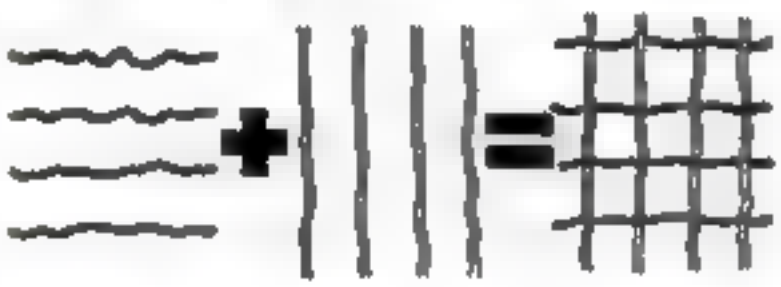
Plastic Velon is made into strong upholstery for autos and busses. It is waterproof, insectproof, and acidproof, and may soon be used in clothing



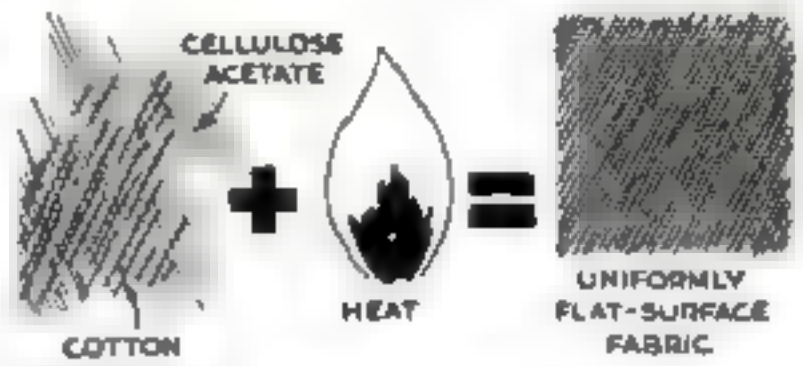
BLENDING combines two or more different staple fibers in one yarn. This attains a quality that neither fiber alone possesses



PLAITING combines a continuous-filament synthetic fiber with a natural-fiber yarn. The resulting thread is called plied yarn

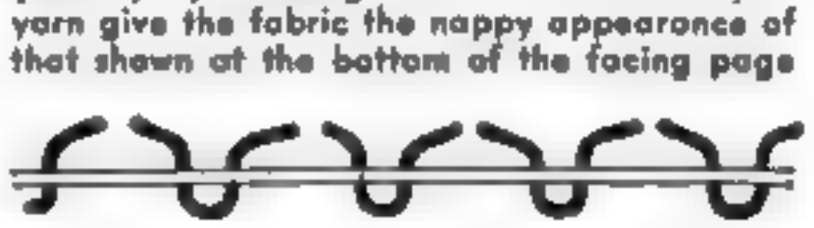


MIXING one synthetic fiber with another or with a natural yarn may be done during weaving. One is the warp and one the woof



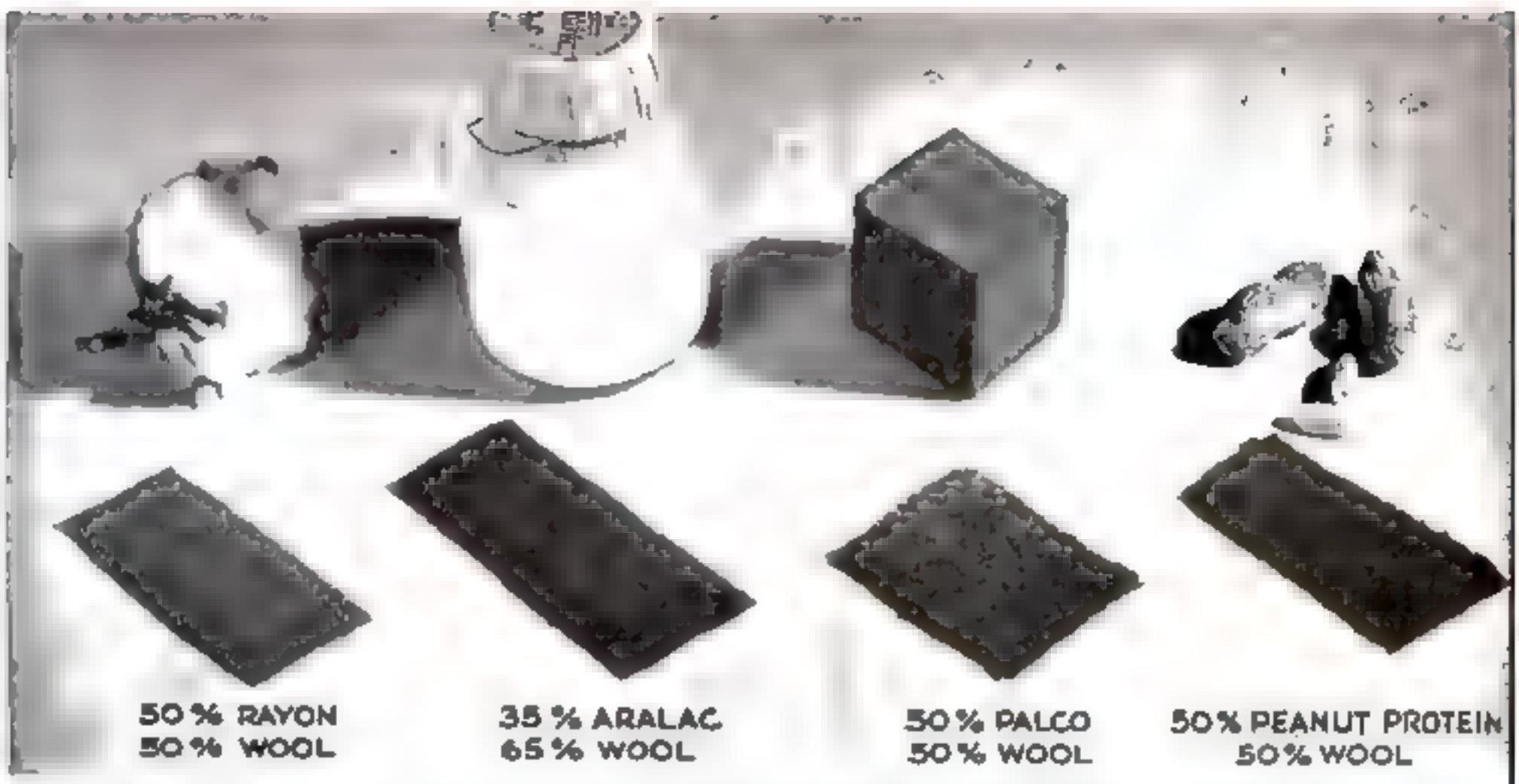
WELDING is a method of making fabric from synthetic yarns without spinning or weaving. It is still in the experimental stage. A natural fiber, such as cotton, is mixed with a cellulose acetate fiber and heated under pressure. At a high temperature the acetate welds the fibers together into a fluffy web. The mass is heated again, this time in an alkaline solution that converts the acetate fibers into cellulose, producing a woollike flannel. Synthetic yarns used for this are acetate rayon, nylon, and vinyl compounds

KNITTING cotton and nylon together in a single operation is a step in the production of nylon fleece. Nylon is looped (above) on a cotton backing, and the loops are then cut (below) by brushing. The free ends of nylon yarn give the fabric the nappy appearance of that shown at the bottom of the facing page



suiting fabric. A couple of Scotch chemists have exhibited small swatches of a fabric half wool and half peanuts. It is softer and more pliable than soybean wool, and in other respects is much like both it and Aralac. From England come reports of a new fiber from kelp, or seaweed, utilizing the protein content, algin, which is a by-product from the extraction of iodine. Algin fabric is completely fire-resistant: a swatch soaked in gasoline was set afire, and the blaze burned out without damaging the cloth.

In Australia experiments are being made with fibers from animal muscle tissue and from leather waste. In occupied France, fabric called "Pilolta" is made from sweep-



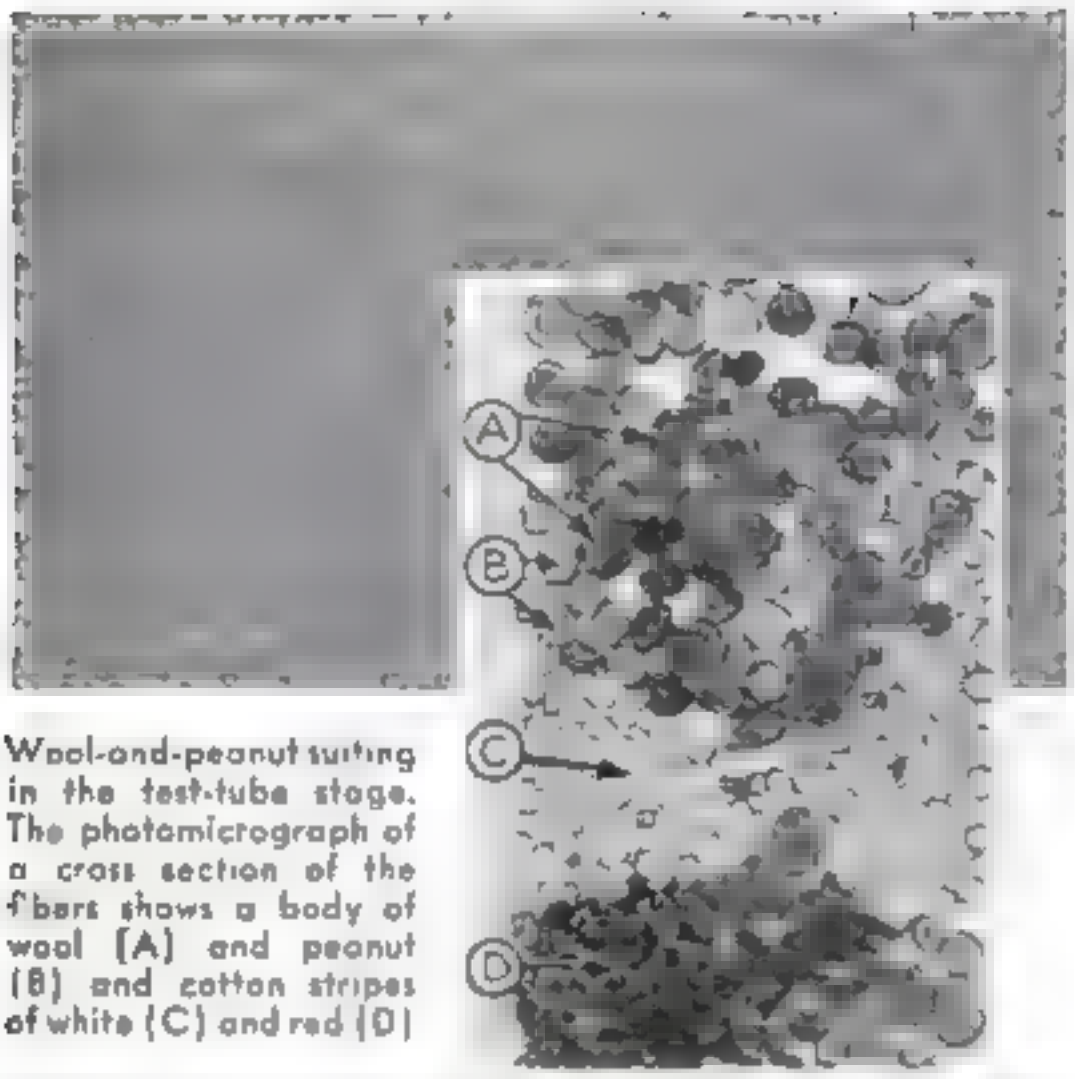
Woollike fibers that never saw a sheep's back are being spun with real wool into blended fibers that make fine, warm fabrics. Here wool is used in four promising blends—with rayon made from cotton linters, with Aralac processed from skim milk, with Palco fiber shredded from the bark of the redwood tree, and with peanut fiber from the peanut kernel. They mark a big step forward in textile research

ings of hair from barber-shop floors. The Germans and Japanese are reported to be working on a fabric made of fish, but they are keeping it secret, not even telling what the finished product smells like.

Fiberglas, extruded in filaments 22/100,000 of an inch in diameter, has electrical and chemical properties that have made it a "must" for war industries short of rubber and silk. It is fire-resistant, waterproof, wrinkleproof, and insectproof, and when no longer needed in the war effort will reappear on the peacetime market in drapes, bed spreads, tablecloths, and the like, and blended with silk or rayon in neckties. Because it does not stand abrasion well and is cold, it has not yet been developed for use in clothing.

Plastics can be converted into strong, warm textiles, and some have qualities of electrical and chemical inertness that no natural fiber can approach. The newest is

Nylon fleece on a cotton backing tailors well, as shown in the photograph above, and withstands wear. Though resilient, it tends to flatten in abrasion tests. Nylon for civilian use, however, will probably be restricted now that its manufacture has been frozen for war needs



Wool-and-peanut suiting in the test-tube stage. The photomicrograph of a cross section of the fibers shows a body of wool (A) and peanut (B) and cotton stripes of white (C) and red (D)

Southern Regional Research Laboratory, U. S. Dept. of Agriculture

Firestone Rubber Company, in charge of its development, believes that Velon can be mixed with cotton and wool as successfully for suitings as for upholstery.

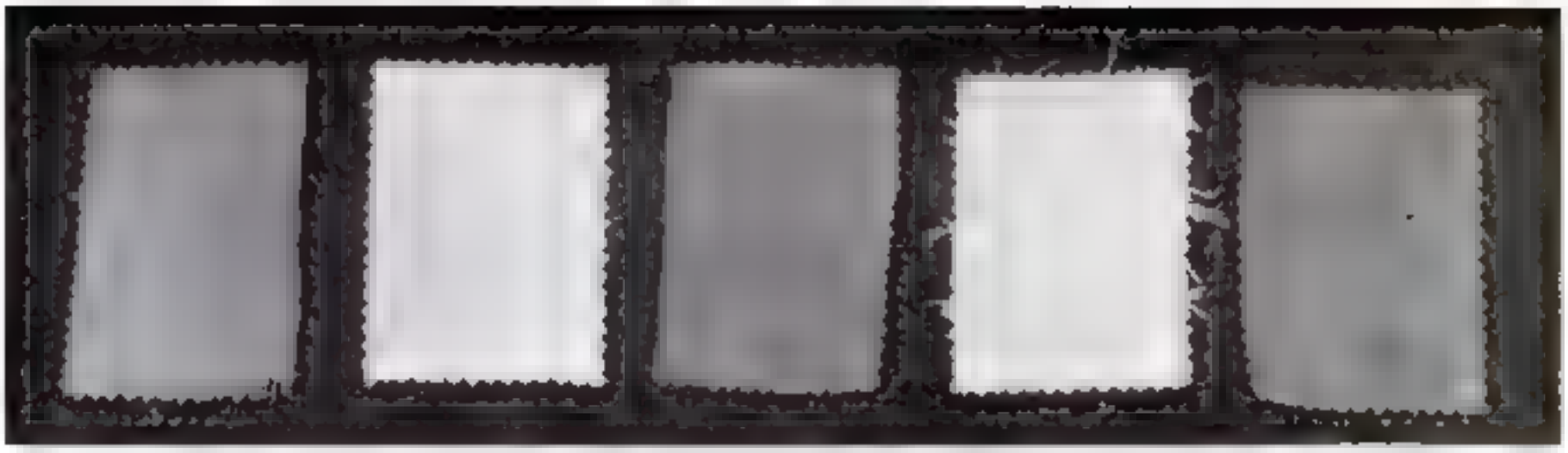
Another plastic fiber with possibilities is Vinyon, a copolymer of vinyl chloride and vinyl acetate. Like nylon, it is extruded in tiny filaments that can be made up into continuous-filament or staple-yarn fabrics. Its use in war work is largely in chemical processes where its resistance to chemicals makes it invaluable as a filter. Low heat resistance—it begins to get tacky at 150 degrees Fahrenheit and can't be ironed—is delaying its use as ordinary fabric, but the American Viscose Company, which is developing it in partnership with Union Carbide and Carbon, reports that this fault is being licked.

vinylidene chloride Velon, which looks much like a shiny, coarse horsehair. It is unaffected by water, most acids, insects, and rot, and is used for upholstery, drapes, handbags, luggage, and also, in a large-size filament, for insect screening in place of copper. Its base is the same as that of plastic water pipes (P.S.M., Oct. '42, p. 73). The

Palco, the bark of the redwood, already used as a substitute for cork in manufacturing insulation (P.S.M. Jan. '43, p. 110), is also being shredded as a wool blender in blankets, heavy-duty Mackinaws, and felt hats, and as a mattress filler. Palco fiber is warm, resilient, tough, water-resistant, and cheap, costing six cents a pound to a

Here a good wool substitute, 18 percent Aralac and 82 percent spun rayon, is stretched to the breaking point, somewhat lower than that of wool

Water that soaks into an untreated fabric, at the right below, is repelled by the Zelan-impregnated sample at left. The finish stands many cleanings



Rayon can duplicate any fabric on the market. Here, from left to right, it doubles as a lightweight worsted suiting with good draping form, as a fresh and crisp sharkskin, as a fleecy wool-type fabric with a lofty nap, as a crease-resistant textured crepe, and as a permanently-marked, handsome moiré

dollar for virgin wool, but is too short and coarse for use unblended.

Rayon, synthesized from the cellulose in cotton or wood pulp (and soon possibly from corn or milkweed stalks), is the oldest artificial fabric of them all. Consumption in the United States topped that of wool in 1941 when it had taken over the field of silk. It can duplicate any fabric on the market

The actual manufacture of all these test-tube fibers, with the exception of Palco bark, includes one controlling process, extrusion. After the raw materials of the synthetic fibers have been reduced to viscous liquid, they are forced through a spinneret having a nozzle with several hundred pin-point holes, going from it into a coagulating bath where they solidify into web-fine filaments.

Two new fabric finishes complete the roster of textile developments. One is Du Pont's Zelan, a long-chain nitrogen-complex liquid that is a semipermanent water repellent and may soon be used on raincoats made without rubber. The other is Koloc which, the United States Rubber Company reports, more than doubles the life of cloth treated with it. Unfortunately a small amount of rubber is required in its manufacture, and that will serve to keep it off the market until sufficient supplies of natural or synthetic rubber are again available.

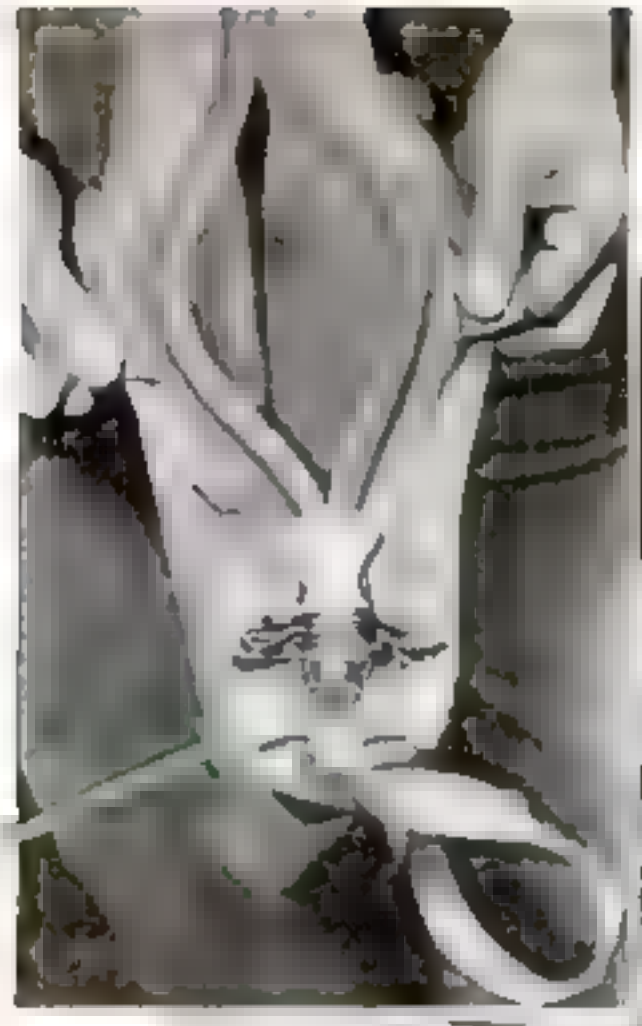
"Teddy-bear" cloth, just to the right, is cotton-backed wool for heavy coats. The all-rayon "brush-knit" fabric, for right, gives other coats a warm lining

Fiberglas yarn drawn from marbles of unblemished glass has been woven into neckties like that above. Now in war work, it makes insulating tape for electric motors and generators

Soybeans, versatile protein, are the source of the synthetic yarn at center. It is used with wool in upholstery fabrics, and its coarseness may be reduced to permit use in clothing

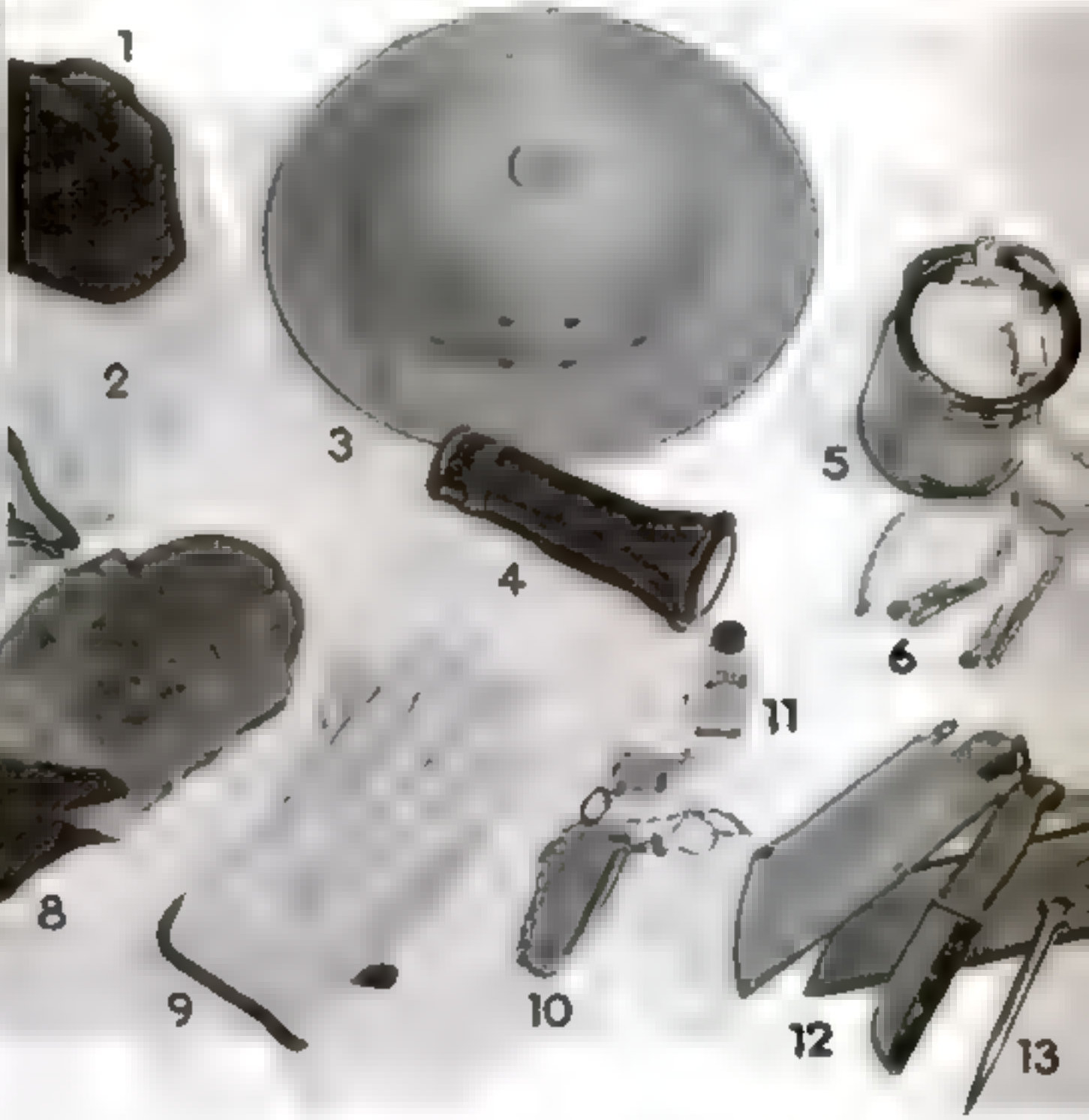
A seaman's most important safety device is this rubber life suit, distinctive features of which are easily visible yellow hood and gloves, weighted shoes to keep him upright in the water, and a watertight zipper. By pulling the wooden knob of the zipper up to his neck, he can make the suit entirely watertight except for the fastener at the neck, which remains out of water. A kapok vest, shown below, adds to his buoyancy. When in dangerous waters, he pulls on the trousers of the suit, and keeps its sleeves tied at his waist so he can get into it quickly

Cheating



This watertight safety bag, designed to carry the items shown below, can also be quickly inflated by mouth to serve as a life preserver

Photographs by Robert F. Smith



What the well-equipped shipwrecked seaman now carries: (1) Wool cap. (2) Chamois leatherette shirt. (3) Tropical helmet. (4) Flashlight. (5-6) Cigarette tin; lighters. (7) Life-belt light. (8-9) Woolen mittens; leather gloves. (10) Jackknife, whistle. (11) waterproofing oil. (12-13) Sheath knives and spike

the Axis Torpedoes

SOUND TRAINING AND GOOD EQUIPMENT NOW BRING SHIPWRECKED SEAMEN BACK TO PORT

BY BERNARD WOLFE

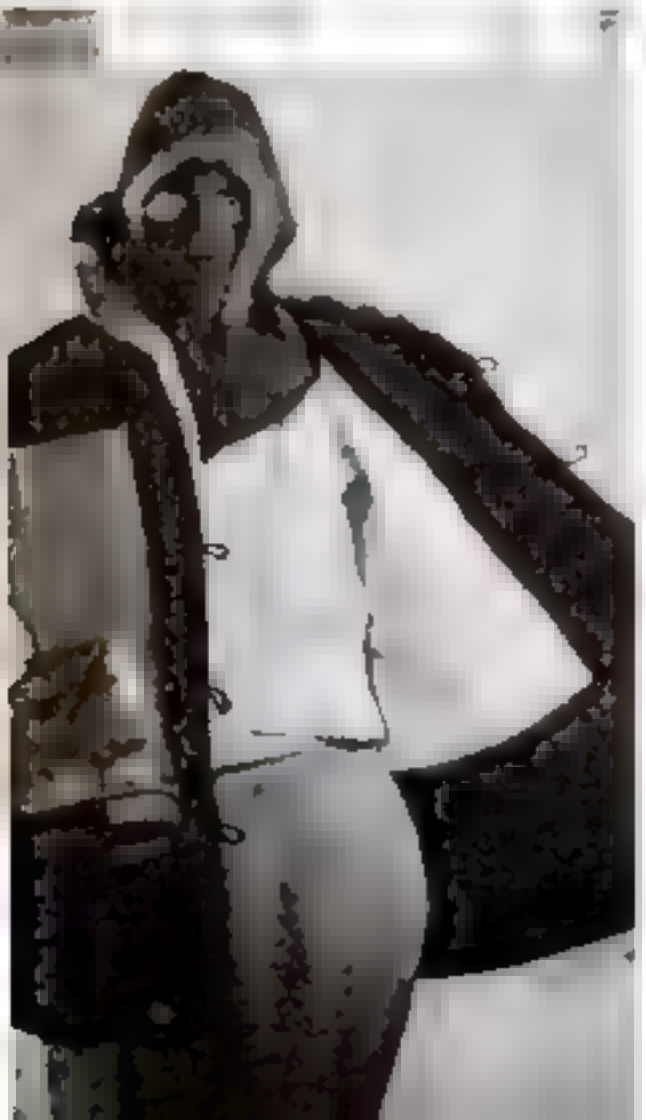
IT WAS all over before you could say "All hands on deck—man the lifeboats!" One minute Marty was standing watch on the graveyard shift, wondering if he really saw a streak of foam creasing the inky waters—the next, the whole ship heaved and shuddered and, with a terrible splintering crash, split in two.

In a matter of seconds, or so it seemed to Marty, the deck he stood on was awash and he was going under. Worse yet, the lifeboats up forward were lost, and Marty's hand had been badly crushed by a hurtling piece of deck plate. But he was in very little danger. For one thing, he had a new-style kapok vest strapped tightly around his torso, and, in addition, his rubber life suit was half on, with the sleeves tied around his waist. In practically nothing flat he had his arms inserted in the sleeves and the helmet adjusted over his head. One yank with his good hand zipped the slide fastener shut up to his neck. His watertight emergency safety bag, full of valuable gear, was right beside him, and in another moment he had it hanging over his

shoulder. Had he been caught without any other equipment, this little bag would have saved the day for Marty, for there was enough air trapped in it to support the weight of two m n in the water.

What subsequently happened to this typical seaman is now a common story among the gallant men of our merchant marine. With his air-filled life suit, his inflated bag, and his kapok vest, he had buoyancy to spare, and he wasn't pulled down very far by the suction from the sinking boat, nor even by the davit guy wire that momentarily coiled around his boots. As soon as he shot to the surface, he kicked himself upright, and the next moment he was flashing the red signal light clamped to the chest of his rubber suit. Some of his shipmates who had managed to lower away one of the life boats aft were attracted by the flickering light, and soon had hauled him into their boat. Here there was an ample stock of sulfa drugs and other medicinal supplies in the emergency first-aid kit, and Marty's hand was carefully attended to.

Even better, the boat was equipped with a portable radio receiving and transmitting set. The ship's radio operator had gone down with the vessel, but there was no difficulty in operating the radio, since it had an automatic signal which flashed repeated SOS's over the international-distress wave length to all ships at sea and coastal listening posts. This distress signal was picked up by a near-by Coast Guard station, which speedily dispatched a rescue

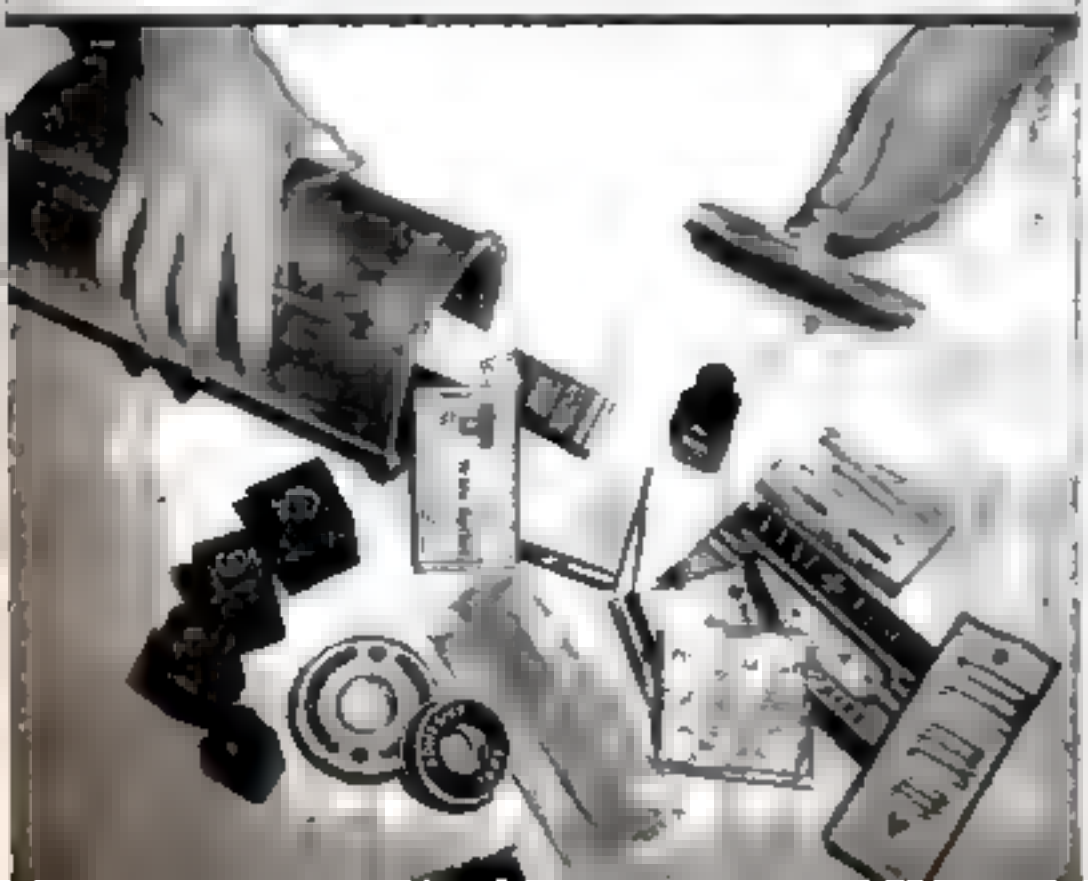


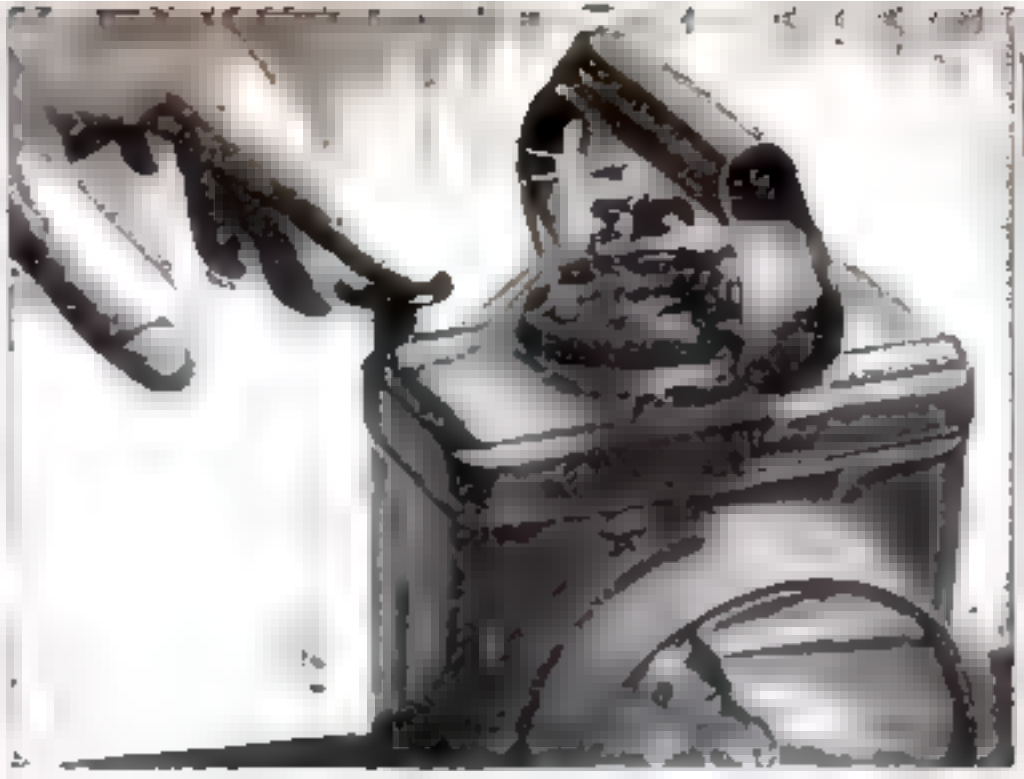
At an Eastern training station, Merchant Marine cadets shown above are instructed in lowering a lifeboat from a pair of davits. At the left, a seaman "models" the clothes used on the Arctic run. These include a fur hood, felt mask, sheepskin-lined corduroy jacket, felt boots with rubber overshoes, and fleece-lined mittens. The drawstring-type Vaco life suit at right has a special flashlight with a spring arrangement, shown below, which enables the wearer to signal passing ships and planes while he is adrift

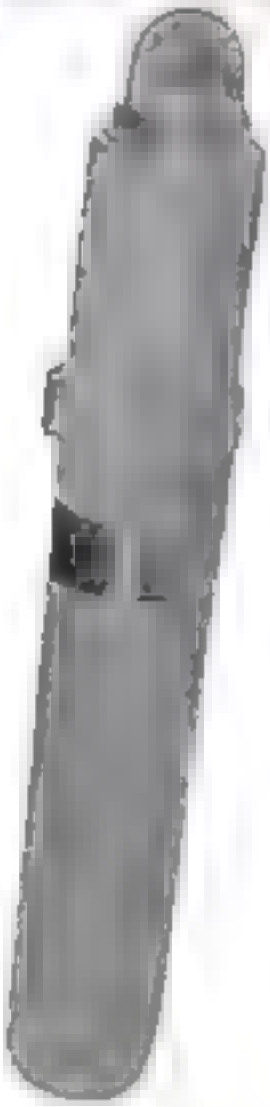
MERCHANT MARINE SCHOOLS TEACH MEN TO PLAY SAFE

The United States Merchant Marine Academy at Kings Point, Long Island, N. Y., is only one of the Government's new cadet schools now training men from civilian life for ratings in the Merchant Marine service. The course takes about a year to complete, and gives an intensive training in the more important phases of seamanship. Most important of all at the moment are the studies in safety seamanship—based largely on the experiences of shipwrecked seamen who have come back to tell how lack of proper equipment and insufficient training can take a heavy toll of lives in torpedoings and bombings. Cadets, in every stage of their training, are now studying and profiting by these experiences. Shown on these pages are some of the lifesaving methods that cadets must master before certification. At left, they climb down ropes and cargo nets in an abandon-ship exercise. At lower left, a cadet jumps from the "deck" to the water in a rubber life suit. At bottom left, with his safety bag under his arm, he waits to be rescued, and below, his comrades haul him in safely.

First-aid kits are also required equipment for all rafts and lifeboats. The watertight container shown below contains, among other necessities, sulfa drugs, tannic acid, splints, gauze, scissors, forceps, ammonia, iodine, adhesive tape, cotton, and safety pins





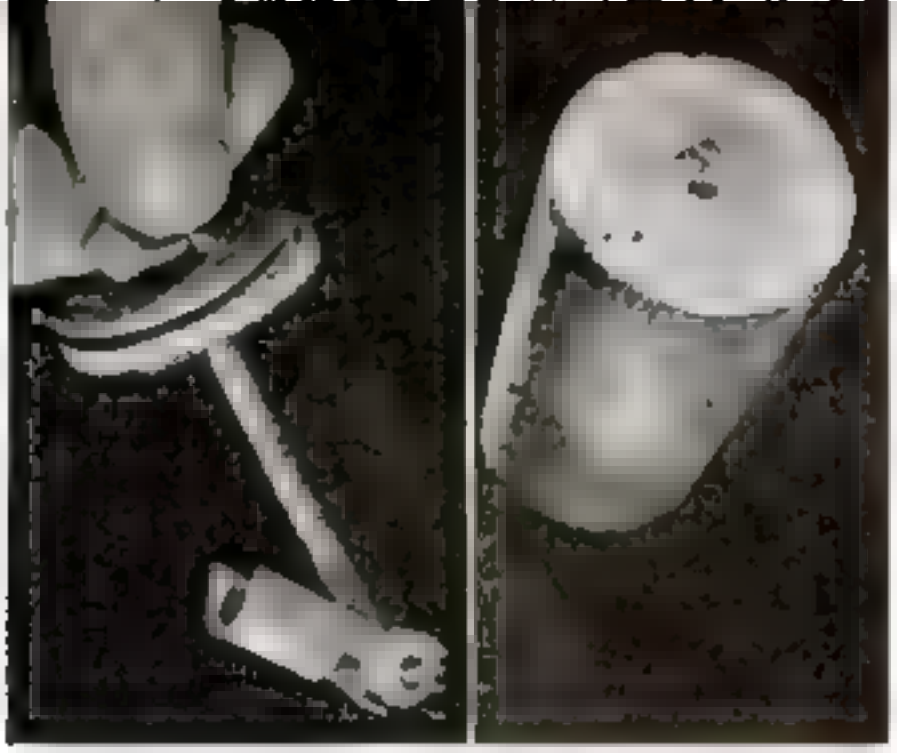


Among the many items shown at the "Safety-At-Sea" exhibit held recently at the New York headquarters of the National Maritime Union are those appearing at upper left. The Delta Morse-code signaling lamp above shows the telegrapher's key with which a shipwrecked seaman can flash the dots and dashes of a message to a passing ship. At lower left are some of the concentrated foods with which every lifeboat must be equipped. Among these are canned pemmican, sweet chocolate, malted-milk tablets, and biscuits. One of the most serviceable pieces of equipment for every seaman who has to abandon ship is the Sculler automatic distress signal shown at the right. This canvas-covered instrument requires no keys or switches to flash its signal. Simply turning it right side up forces down an internal weight which makes a contact and lights the bulb. It is watertight and extremely durable

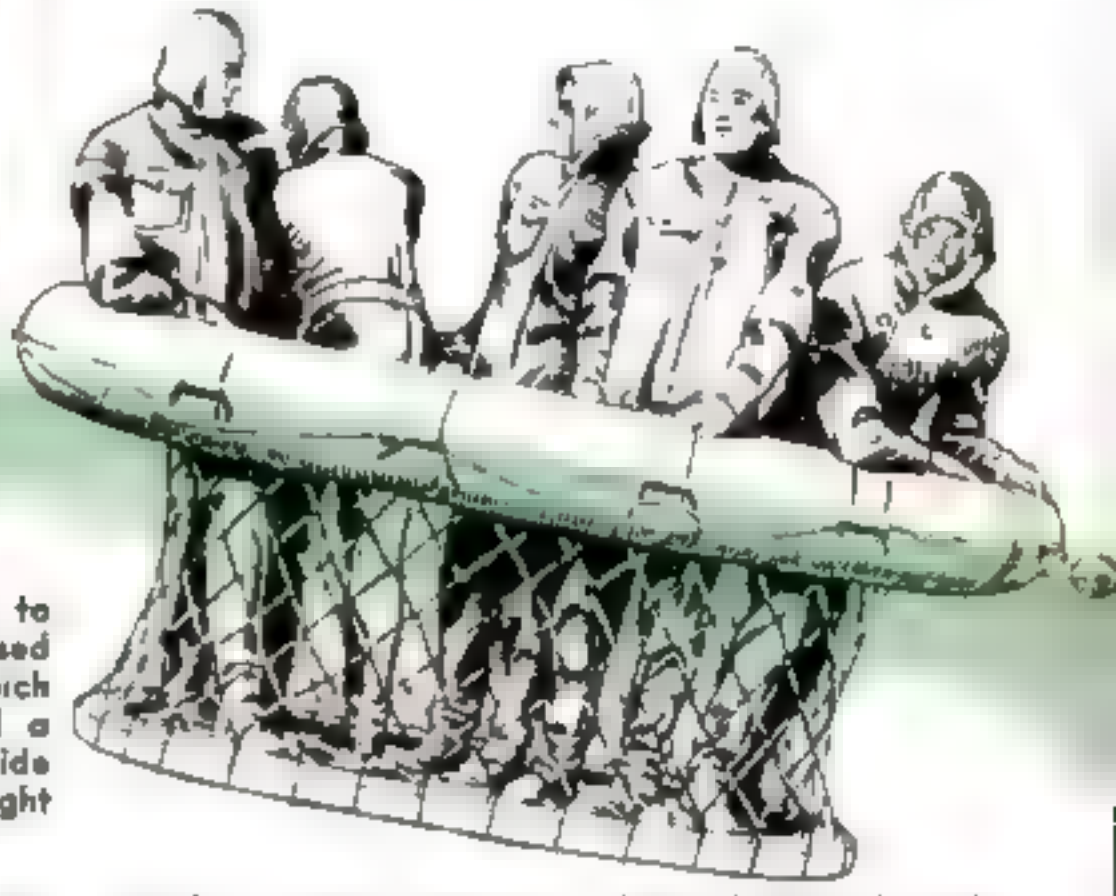
boat. There was no trouble in finding the lifeboat a few hours later, because Marty's comrades kept shooting up brilliant red parachute flares from their signaling gun.

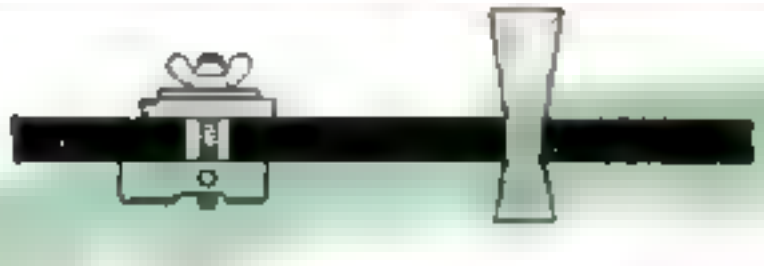
Today, a little more than a year after the opening shot of the war, the United States merchant marine has become expert in meeting all emergencies at sea, and is being equipped with a host of lifesaving devices which bid fair to make it the safest merchant fleet in the world.

How this safety streamlining was accomplished is a story of close co-operation between the Navy, the Coast Guard, the Maritime Commission, the War Shipping Administration, and hundreds of sailors in the maritime unions—men like Marty and his mates who came back from sea with recommendations based on first-hand experience. Early in the war, the National Maritime Union, for example, drew up a



The "doughnut" raft below is used when lifeboats and rafts are unavailable. Made of canvas-covered cork, it has a rope-supported submerged platform for use by injured or exhausted men. Rope coils attached to the sides permit men in the water to hold onto the raft





Lifeboats riddled with machine-gun bullets add to seamen's difficulties. Two kinds of plugs are used to stop up the holes: a wooden conical plug which will fit into almost any size bullet hole; and a metal plug whose toggle bar opens on the outside of the hole, allowing washer to be screwed tight

safety program designed to save lives, ships, and cargoes from avoidable loss. Included in this program were urgent pleas for better loading of ships; the proper provisioning of lifeboats; the installation on all merchant ships of lifesaving suits, rafts, and defensive arms; the reconditioning of quarters to accommodate Navy gun crews; compulsory lifeboat and fire drills on every boat before leaving port; the keeping of lifeboats swung out on their davits at all times; the establishment of an adequate coast patrol through the requisitioning of small private craft; the organization of safety committees aboard all ships; and a thorough training program for new men.

Government experts, engaged in elaborate research on their own, listened carefully to the men who man the ships and in many instances adopted their suggestions. Government agencies then swung into action by drastically tightening the regulations covering equipment and behavior on board merchant vessels. Local Merchant Marine inspectors in every port, operating under the Coast Guard, went over every ship from stem to stern, checking the safety equipment and supervising the installation of new gear. The Division of Training of the War Shipping Administration, under Telfair Knight, director of the division,and Captain R. R. McNulty, assistant director and supervisor of the Merchant Marine Cadet Corps, has set up 13 centers for the training of thousands of men. Some of these centers are cadet schools which are training men from civilian life and seamen up from the fo'csle for both licensed and unlicensed ratings in the Merchant Marine. Others, like the huge Sheepshead Bay Maritime Training Station at Oriental Point, N. Y., are preparing men to be stewards, deck hands, and boiler-room apprentices. In every school a strenuous Safety Seamanship Program has been instituted.

The United States Merchant Marine Academy—located at Kings Point, L. I., on the luxurious grounds that were formerly the estates of Walter P. Chrysler, Nicholas Schenck, and the late movie star, Thomas Meighan—is typical of the Government's cadet training centers. Entrance requirements are every bit as tough as the Navy's. Only high-school graduates of good character, and who can pass stiff physical and intelligence tests, are admitted. Cadet officers, taken from civil life, receive 10 weeks of preliminary training, then spend six months at sea, and finally return to school for six to eight months of additional instruction. Their classes cover naval science, seamanship, navigation, cargo loading, ship construction, lifeboat certification, and a heavy dose of Safety Seamanship—in other words, a course of study that runs the whole nautical gamut.

Before certification, the cadets go through a four-hour drill which simulates the actual conditions of a vessel under fire. This is the acid test, and it takes real proficiency to survive it. Some of the men, designated as casualties, are lowered into lifeboats and given first-aid treatment while the crew is pulling away *(Continued on page 814)*

MYSTERY MATERIAL

SCIENCE HAS DISCOVERED UNDREAMED-OF WAYS TO

By HERBERT ASBURY

ALTHOUGH man has manufactured glass for some 10,000 years, he still doesn't know precisely what it is or how to describe it accurately. The scientist may call it "a super-cooled liquid," or "an amorphous solid," but these and other definitions don't describe glass in the sense that H_2O, for example, describes water. No true chemical formula for glass is known, because its chemical constitution and molecular structure are mysteries which not even the microscope and the X-ray have been able to solve.

From remotest antiquity this mysterious substance has been used by man for his safety, comfort, and adornment. Artifacts of obsidian, glass manufactured by nature through volcanic action, have been found in almost every country of the world. The savage of the Stone Age chipped knives and spearheads from fragments of obsidian, and as early as the Bronze Age the substance was sold and bartered as an important article of commerce. For thousands of years it was in demand for weapons, jewelry, and mirrors, but its importance began to decline when the first artificial glass appeared about 8,000 B. C.

In the modern world glass is everywhere. We drink from glass and preserve our food in it. We look through it, into it, and use it for protection from the weather. It enables the optical scientist to measure and control light, and the astronomer to see and photograph the planets and the stars. It makes possible the spectroscope and the microscope, the cathode-ray tube and the X-ray machine, and the myriad instruments of a great research laboratory. A world without glass would be dark, dreary, and uncomfortable; to millions it would also be blurred and dangerous.

The pace of technological advance in the glass industry has been tremendously accelerated by the war, and American manufacturers are producing new types of glass which are not only proving satisfactory as substitutes for critical materials, but are being used in the actual fabrication of weapons. Perhaps the most important of these discoveries have been made in optical glass, the manufacture of which is one of

OF A THOUSAND USES

USE GLASS—BUT STILL HASN'T FOUND OUT JUST WHAT IT IS

America's most carefully guarded military secrets. In this field the new glasses have enormously increased the efficiency of our range finders, detection devices, aerial cameras, and other precision instruments used by the armed forces. One new glass is being ground into lenses which will enable observers to look directly at the sun with clear vision, and so spot dive bombers and other approaching aircraft. Another will blot out all reflected glare, but the lens ground from it can be rotated by hand to exclude as much light as desired. A third, the first glass made without sand, has a much higher refractive index than any glass previously manufactured. Applied to aerial cameras, it will give better definition and cover a larger area with no loss in lens speed.

New uses for glass in ammunition, and in the actual manufacture of ordnance, are of equal importance, but cannot be revealed. Two of the country's largest glassmakers, Libbey-Owens-Ford and Pittsburgh Plate Glass, are making a glass up to four inches in thickness, which will stop a .50 caliber bullet, and are fabricating housings for pilots and bombardiers out of bent laminated safety glass. A year ago both of these glasses were considered impossible to make.

To alleviate a shortage of cork for low-temperature insulation, and of magnesia, asbestos, and other materials for high temperatures, the Pittsburgh-Corning Corporation has developed Foamglas, (P. S. M. Nov. '42, p. 49).

The Corning Glass Works are making automobile batteries of glass for the first time, using their famous heat-tempered Pyrex, and are thus conserving lead and rubber. Various metals are being saved by the use of glass springs for stresses of 2,000 pounds per square inch. In many respects glass is superior to steel for this purpose. It is more truly elastic, retains its elasticity over a broader temperature range, is immune to acids, and is apparently immune to fatigue. One such spring showed no signs of failure after 8,000,000 deflections in a sulphuric-acid mist.

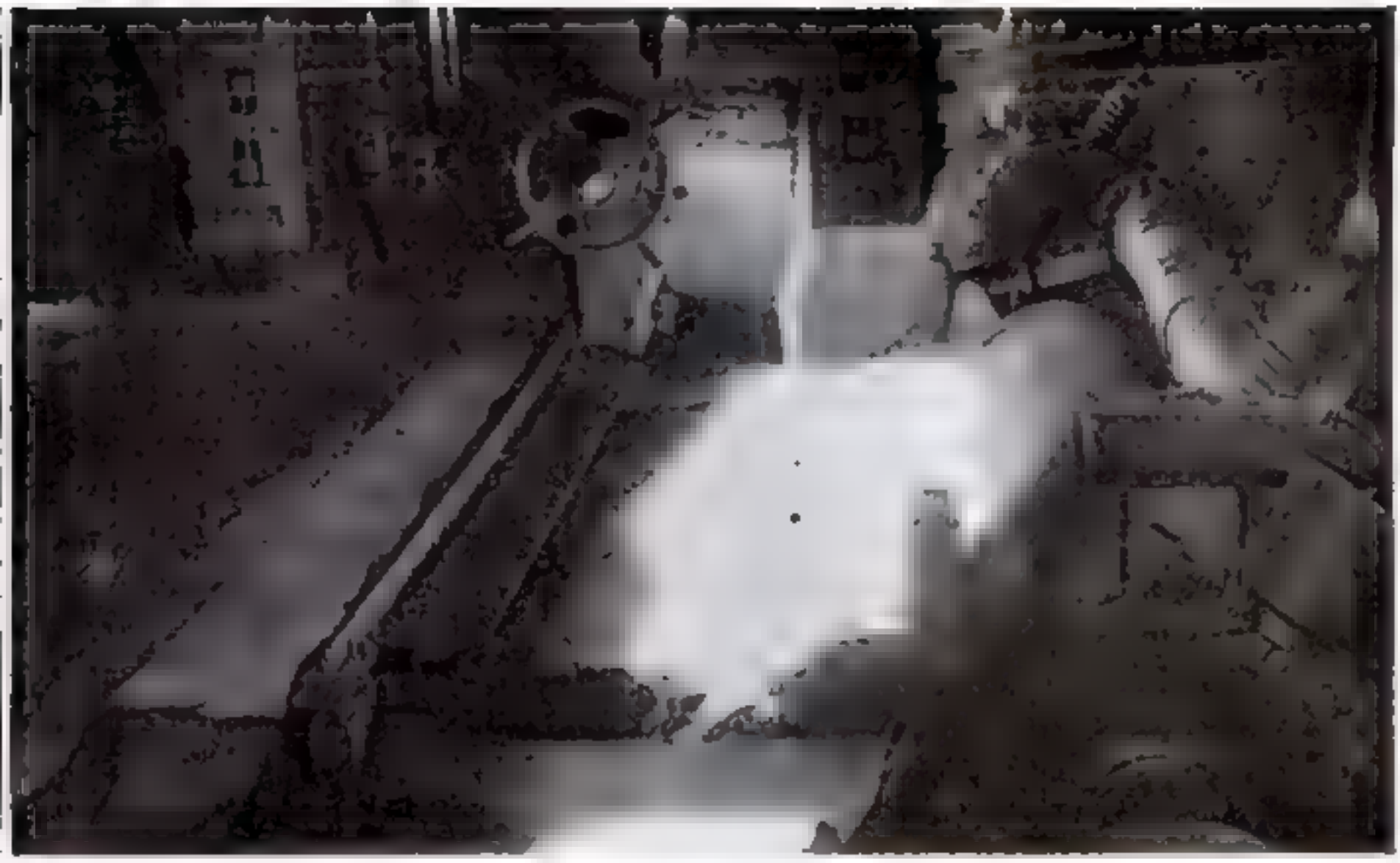
Extensive use of the new fiber glass for heat insulation and interior finishing in ships and airplanes is *(CONTINUED)*

1 Glass making starts with precise weighing of silica, limestone and other ingredients. Here the operator is keeping his eye on the delicate scale as he lets a handful of material dribble through his fingers

2 The batch of ingredients is now put into huge clay pots which are inserted in this high-temperature furnace. Merely by varying the materials that go to make up the batches, the Corning Glass Works manufactures as many as 300 types of glass

4 Shown below is one of the long cast-iron tables on which the plate glass will rest during grinding and polishing. Plaster of Paris is spread on the table to hold the glass securely when the table is pushed under the battery of grinders shown in the background

5 Looking like enormous phonograph disks, spinning swiftly on turntables, this series of polishing wheels puts the finishing touch to the surface of the glass. Prior to this, the glass has been ground from rough to smooth. For abrasives, sand is used in the grinding, and iron oxide in the polishing



3 From the furnace, the molten glass is carried to this machine by means of cranes. Here the glass is shown being poured from a pot into the rollers which flatten the glass to the desired thickness. As soon as this thickness is attained, the hot glass is passed along on rollers to the annealing room—a long brick tunnel through which the glass moves slowly. In this manner the plate glass is carefully cooled, finally emerges as rough glass, and is ready to be ground and polished

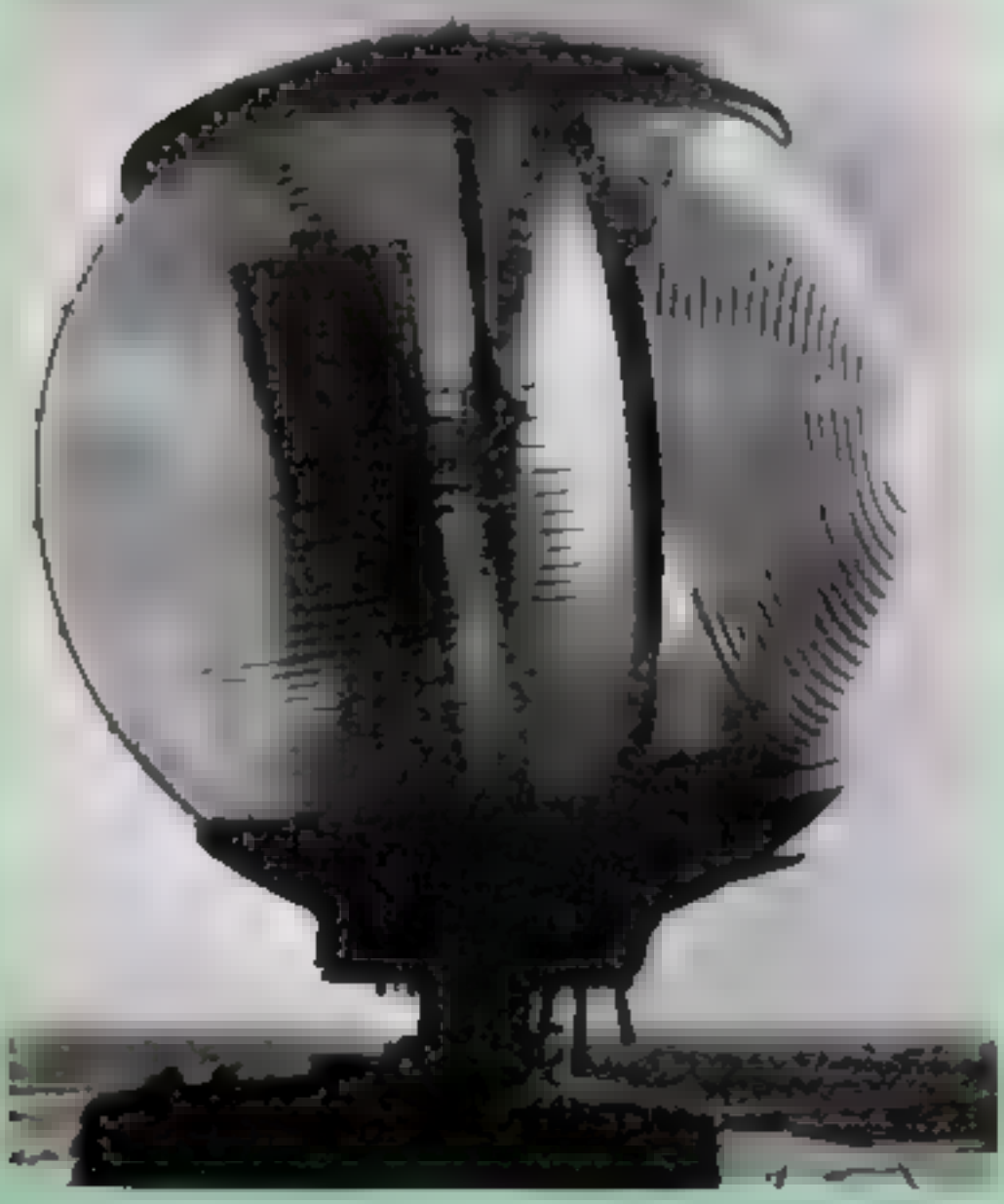
6 Following the polishing process, the glass plates are washed and dried, and then by means of raising and lowering platforms, they are stood up on edge and carefully examined by highly trained inspectors. Should imperfections occur, they are marked on the glass, which is then sent to a room where it is cut on automatic machines. When the imperfections have been eliminated, the glass is ready for shipment. Although the entire process is one of delicate measurements and skillful operations, from the time of the melt to cutting the glass for market it actually takes but a few hours

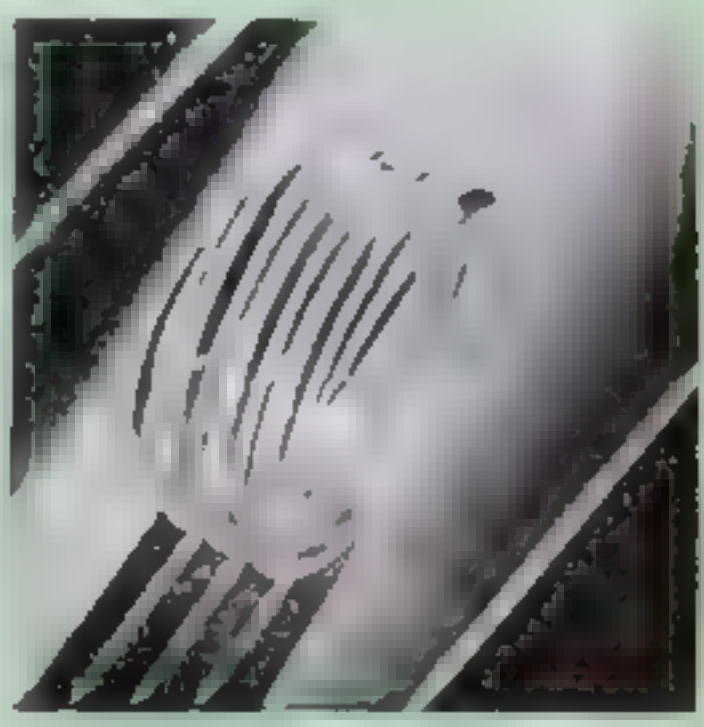
estimated by the Navy to have saved 6,000,000 pounds of aluminum in the first eight months of the war. This glass is also being utilized for camouflage, is replacing asbestos in electrical equipment, and is being spun into textiles for military purposes. Improved manufacturing methods now permit the glass used as electrical insulators to be formed into intricate shapes having threads, holes, and other design details. Glass plumbing is beginning to replace lead, steel, and copper, and a new tempering treatment makes the glass pipe suitable for hot-water service.

Two discoveries in particular have helped make these applications possible and hold great promise for the future. They are an extremely hard plate glass manufactured under various trade names by the Pittsburgh Plate Glass Company and others, and a 96-percent silica glass developed by H. P. Hood and M. E. Nordberg of Corning Glass Works. The importance of the latter glass, the discovery of which has been hailed as one of the outstanding scientific achievements of the century, lies in the fact that it is almost pure fused silica, and very nearly closes the gap between glass and quartz. It has unusual chemical stability, an extremely high softening point, remarkable transparency to infrared and ultraviolet radiation, and great resistance to thermal shock; it can be heated white-hot and thrust into cold water without damage.

In devising methods of manufacturing the 96-percent silica glass, Hood and Nordberg found that they could begin with a borosilicate glass of about 75 percent silica. This was of great importance, for it enabled them to avoid the high temperatures necessary to melt a glass of very high silica content. The melting point of the high crystal form of silica, for instance, is 1,710 degrees centigrade, which can be reached only in specially built furnaces. After melting the borosilicate glass in the usual manner, the product is subjected to a heat treatment which causes it to separate into two distinct phases, one of which is very high in boric and alkali oxides and is soluble in 3N-HCL, or 5N-H_2SO_4, at about 98 degrees centigrade. After being immersed in one of these solutions one day for each millimeter of thickness, the soluble phase is completely leached out, but the other, which is almost pure silica, is not affected. The glass is then washed and dehydrated at high temperatures, a process which causes it to shrink about 20 percent and closes all of the large number of minute pores. The

GLASS NOW DOES





Springs made of glass have proved to be one of the marvels of modern engineering. Recently one of these glass gadgets was put in a flexing machine and left there for a few days. When it was finally taken out it was in excellent condition—after eight million deflections! The lenses in the modern revolving airport beacon at the left are among many products made by Corning Glass

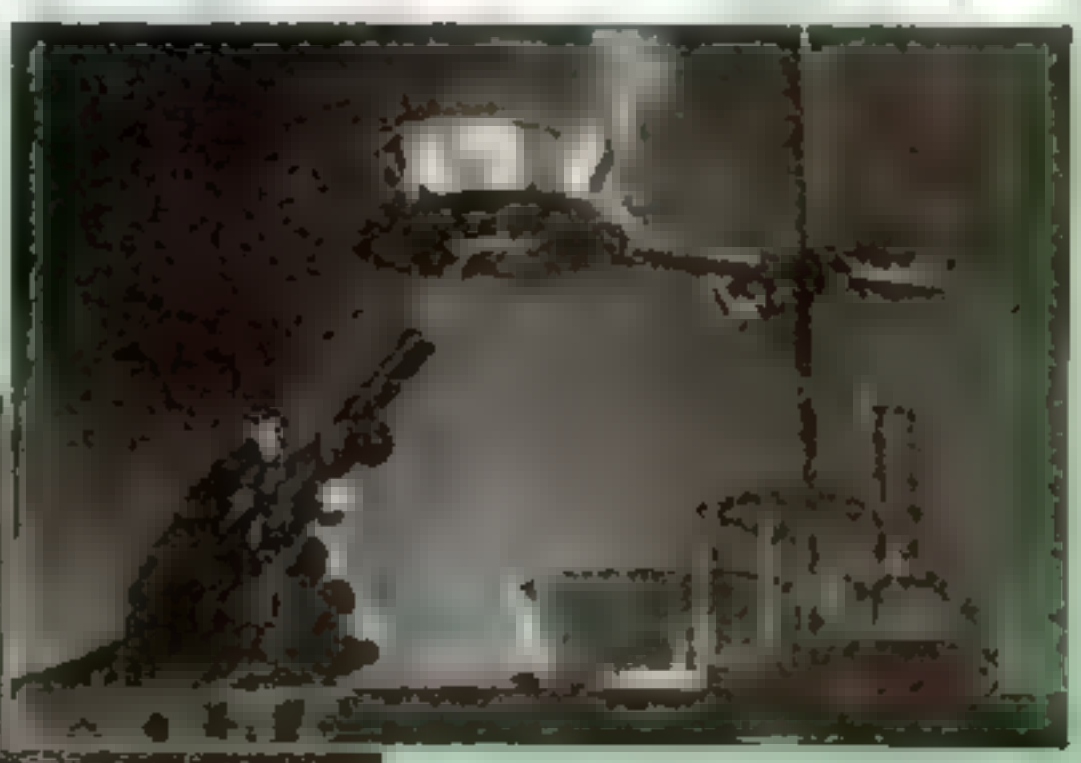
result is a nonporous, transparent glass. Because of the remarkable method of manufacture, it is generally known at Corning as "resurrection glass."

The new hard glass, a tempered plate glass made by a quick annealing process which neutralizes the forces of expansion and contraction, has many of the characteristics of the 96-percent silica glass, and in other respects approaches the glassmaker's dream of malleable glass. It can be bent while in a plastic state and tempered in almost any shape and at any desired angle. It is 4½ times as strong as ordinary plate glass, and is heat resistant up to 550 degrees Fahrenheit. A pane of this glass, resting upon a cake of ice, is not damaged when molten lead is poured upon the upper surface, while a two-pound steel ball, dropped from a height of six feet, will bounce off without leaving even a scratch. A sheet of hard glass, supported only at the ends, will hold a three-ton elephant.

A surprisingly large number of chemicals, each of which must be as nearly pure as possible, enter into the composition of the various types of commercial glass made in the United States, but most of them are added to the melt in small quantities to give the glass certain definite chemical and physical properties. The basic ingredients of every mixture, or batch, are silica, or sand, to the extent of from 60 to 80 percent by weight; limestone, burned or raw, about 13 percent; and soda ash in approximately the same proportions. Two other substances which are almost always included are sodium sulphate, to reduce the amount of seed and bubble and act as a refining agent; and cullet. The latter is glass of the same composition left over from a previous melt. It assists in the melting, and bears about the same relation to glass making as scrap iron does to the manufacture of steel.

If the glass scientist wants to increase the permanence and viscosity of a glass, he adds a little aluminum oxide to his formula. Barium is used in special optical glasses to increase the index of refraction. Boron will both increase the fusibility of glass and reduce the coefficient of expansion. Cerium helps cut out infrared radiation. The number of different glasses manufactured is even larger than the number of substances which may enter into their composition. In an average year one company alone, the Corning Glass Works, will melt almost 300 different types of glass.

THE "IMPOSSIBLE"—AND PROMISES TO DO A LOT MORE



This evaporation dish is one of the first of the 96-percent-silica glass items made by Corning. Molten metal can be poured into it when it is thoroughly chilled and it will not break or crack

Glass tubing has now been made so sturdy that it is beginning to replace lead, steel, and copper in plumbing. A new method of tempering the glass makes it suitable for any type of hot-water service

What does the American flyer look like? Here are the measurements of the typical pilot, average of 1,871 young men in the Air Forces

Height	5 feet 9 inches.
Weight	154.3 pounds.
Arm span	71½ inches.
Reach	35 inches.
Shoulders	17¾ inches.
Chest diameter	8 inches.
Waist diameter	8 inches.
Chest circumference	36¼ inches
Waist circumference	30 inches.
Head (7⅛ hat)	22¼ inches.
Biceps	11½ inches.
Forearm	9½ inches.
Thigh	20⅝ inches.
Calf	14 inches.
Height, seated	36¼ inches.
Back to knee, seated	23⅜ inches.
Knee to floor	21¾ inches.
Breadth of seat	14 inches.
Foot length	10½ inches.
Hand length	7⅝ inches.

ANTHROPOLOGY SHOWS YOU

THE TYPICAL AMERICAN FLYER

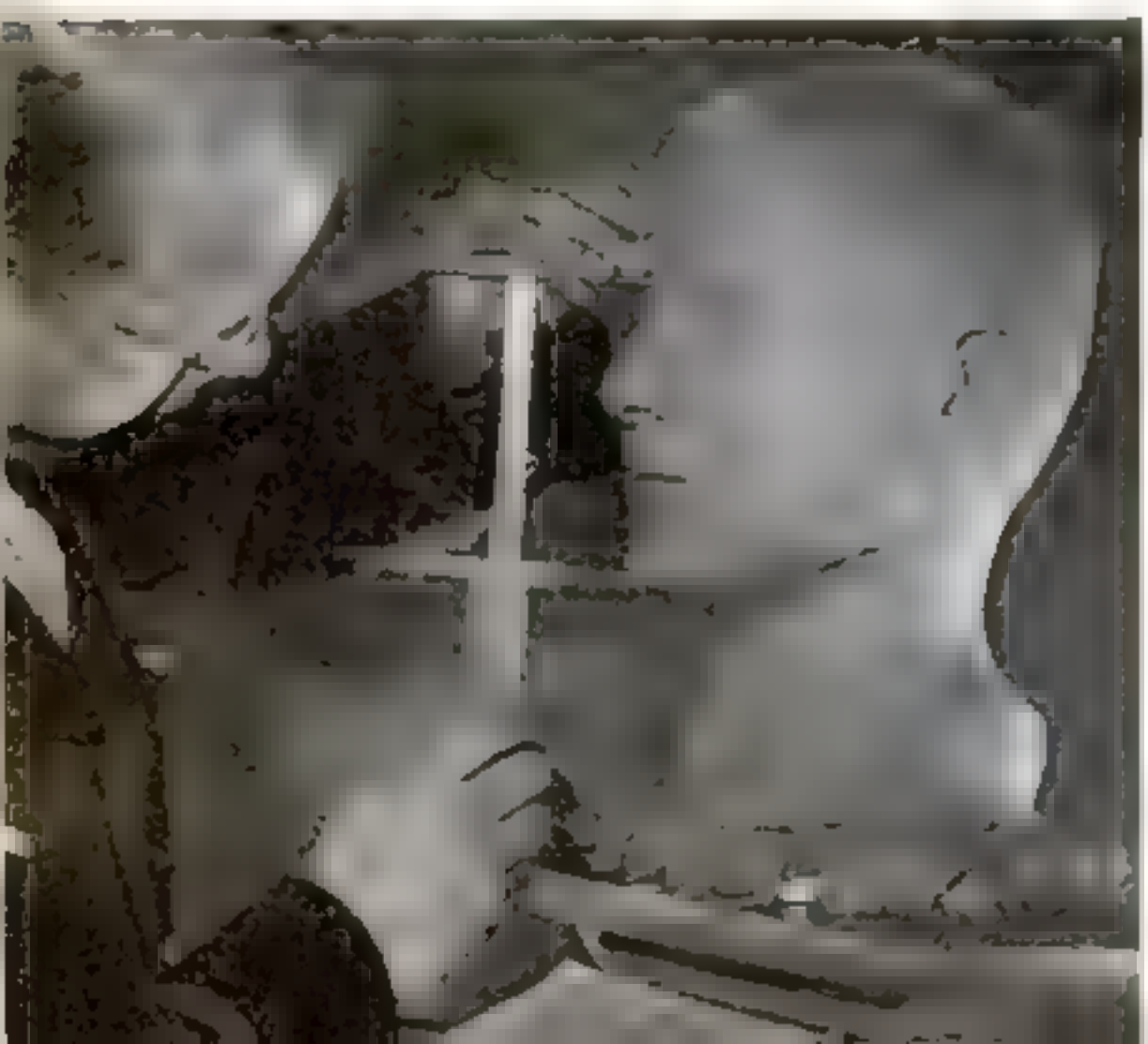
By HICKMAN POWELL

Photographs by William W. Morris

SHORTLY after America entered the war it was discovered, in the testing of an experimental bombing plane, that while a flyer of average size could easily squeeze through the escape hatch to bail out of the ship, a big flyer could not possibly make a jump without first taking off his parachute. The hatch had been made too small.

This embarrassing "bug" was immediately corrected by the manufacturer, but meanwhile it had performed an immensely useful service. It had emphasized and dramatized an important fact which was beginning to be realized at the Aero-Medical Research Laboratory at Wright Field: designers of flying equipment did not have enough precise knowledge of the shape and size of the young men who were going to use it. *(CONTINUED ON PAGE 100)*

Anthropology plays its part in the design of flyers' masks. Here Lieutenant Randall checks a model with sliding calipers



Finishing touches are put on one of the clay heads in the Army's series


Plaster cast of the average U. S. flyer's head, in profile and three-quarter view, taken

II

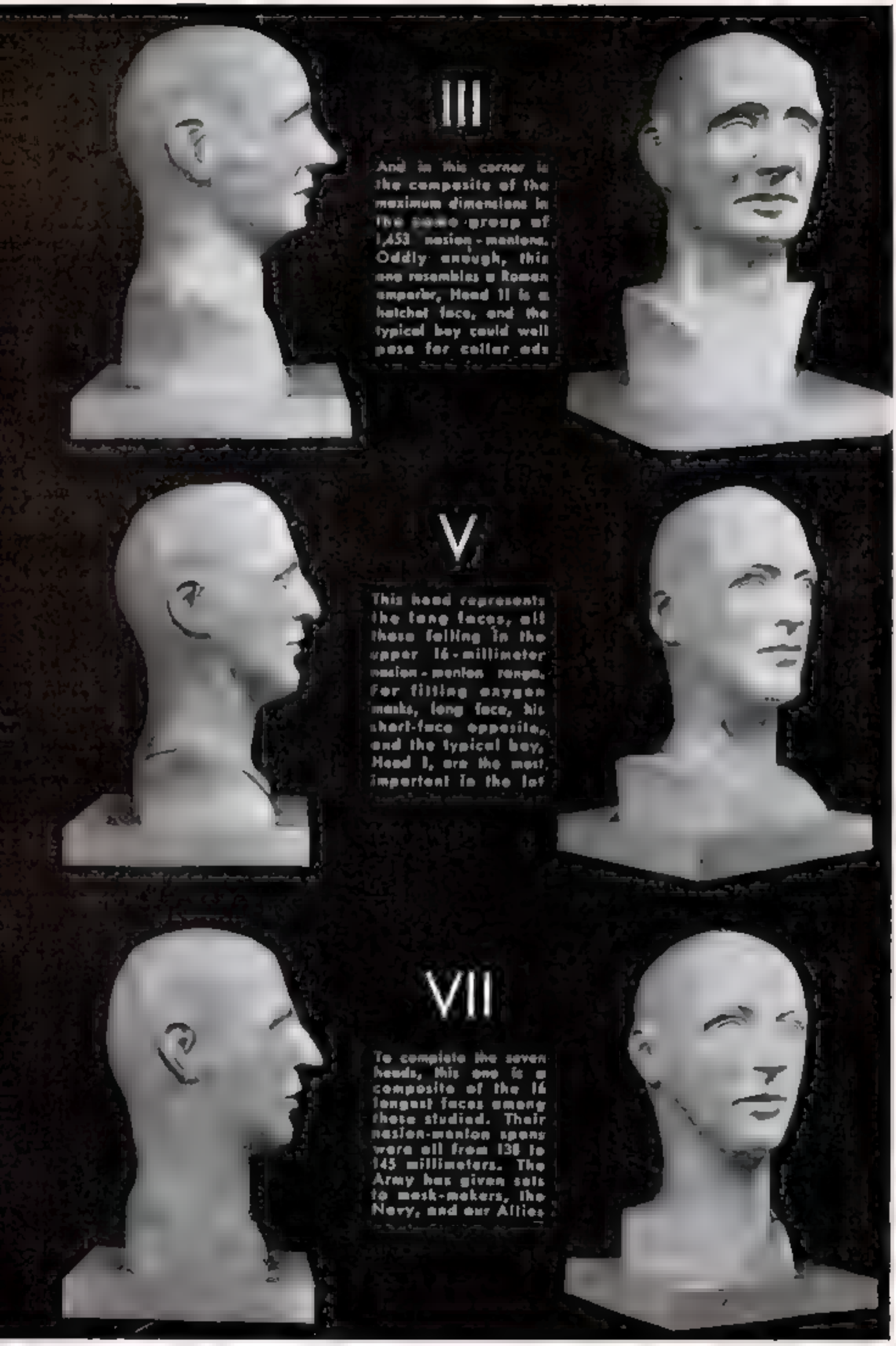
Here is a composite of all the minimum dimensions of 1,453 flyers. They were the ones measured whose nasion-menton (nose root to chin tip) span came within a millimeter of that of the typical flyer on the preceding page

IV

Short faces, roughly a third of the flyers studied, are combined in this cast. The nose-root to chin-tip measurements varied from 145 millimeters to 102, and this one was taken from all those in the shortest 15 millimeter class

VI

Composites were also made of the extremes. This cast combines the average features of the 16 flyers who had the shortest of all the 1,871 faces measured. These 16 had a nasion-menton dimension of but 102 to 108 millimeters


III
And in this corner is the composite of the maximum dimensions in the same group of 1,453 nasion-menton
Oddly enough, this one resembles a Roman emperor, Head II is a hatchet face, and the typical boy could well pose for collar ads
V
This head represents the long faces, all these falling in the upper 16-millimeter nasion-menton range. For fitting oxygen masks, long face, big short-face opposite, and the typical boy, Head I, are the most important in the lot
VII
To complete the seven heads, this one is a composite of the 16 longest faces among those studied. Their nasion-menton spans were all from 138 to 145 millimeters. The Army has given sets to mask-makers, the Navy, and our Allies

To avoid trespassing on the flyers' physical limitations, as designers strained to make the best use of every ounce and inch of an airplane, it became more and more important to have such knowledge.

In one special field it was immediately and urgently needed—the design of oxygen masks for high-altitude flying. This kind of flying has been made possible by improvement in oxygen equipment no less than by development of engines and planes; but the masks in use are still far from perfect, even though the late models are guarded as prime military secrets. One great problem is to design a mask, preferably not of rubber, which can be turned out by mass production in as few sizes as possible and will operate with a minimum of leakage on the great variety of faces to be found on the thousands of flyers in the Air Forces.

When Thunderbolt meets Messerschmitt at 30,000 feet, a mere one-percent advantage in mask efficiency may well mean the difference between victory and death. And mask efficiency is a matter of anatomy.

Col. Otis O. Benson, Jr., chief of the Aero-Medical Laboratory, consulted Prof. Earnest A. Hooton, the noted physical anthropologist of Harvard University, and together they worked out a program of research aimed to classify the physical characteristics of the American flyer. Hooton picked out four of his star students, experts at using slide calipers, spreading calipers, anthropometers, and other precisely scaled instruments for measuring the topography of the human body. Last February they set to work in two teams at Air Force replacement centers, making detailed studies of the heads, limbs, and bodies of the young men entering the Air Forces.

Today the first tangible results of that study are embodied in seven sculptured heads, representing precisely measured composites of all the types of faces found among 1,871 young men. Graduated from long to short, the seven heads present a graphic demonstration of the broad range required in a satisfactory form-fitting oxygen mask.

Since autumn, plaster replicas of these seven heads have been in service in the designing rooms of all manufacturers of oxygen equipment, serving as embodied specifications. Varied as the faces may seem, they actually represent a simplification of the problem, for in relation to the physiognomy of the people as a whole, flyers run pretty much to type. Earlier advances in mask design were made almost entirely by medical doctors who, lacking any large group of aviators as models, tried out their devices on the faces of hospital patients. Obviously the air force cadets, selected for youth and physical fitness, will have a different range of facial contours from any collection of invalids.

Engineers working on mask design are able to mold their experimental masks directly on the faces of the plaster casts, knowing that with certain allowances for flexibility they can fit almost anybody in the air force.

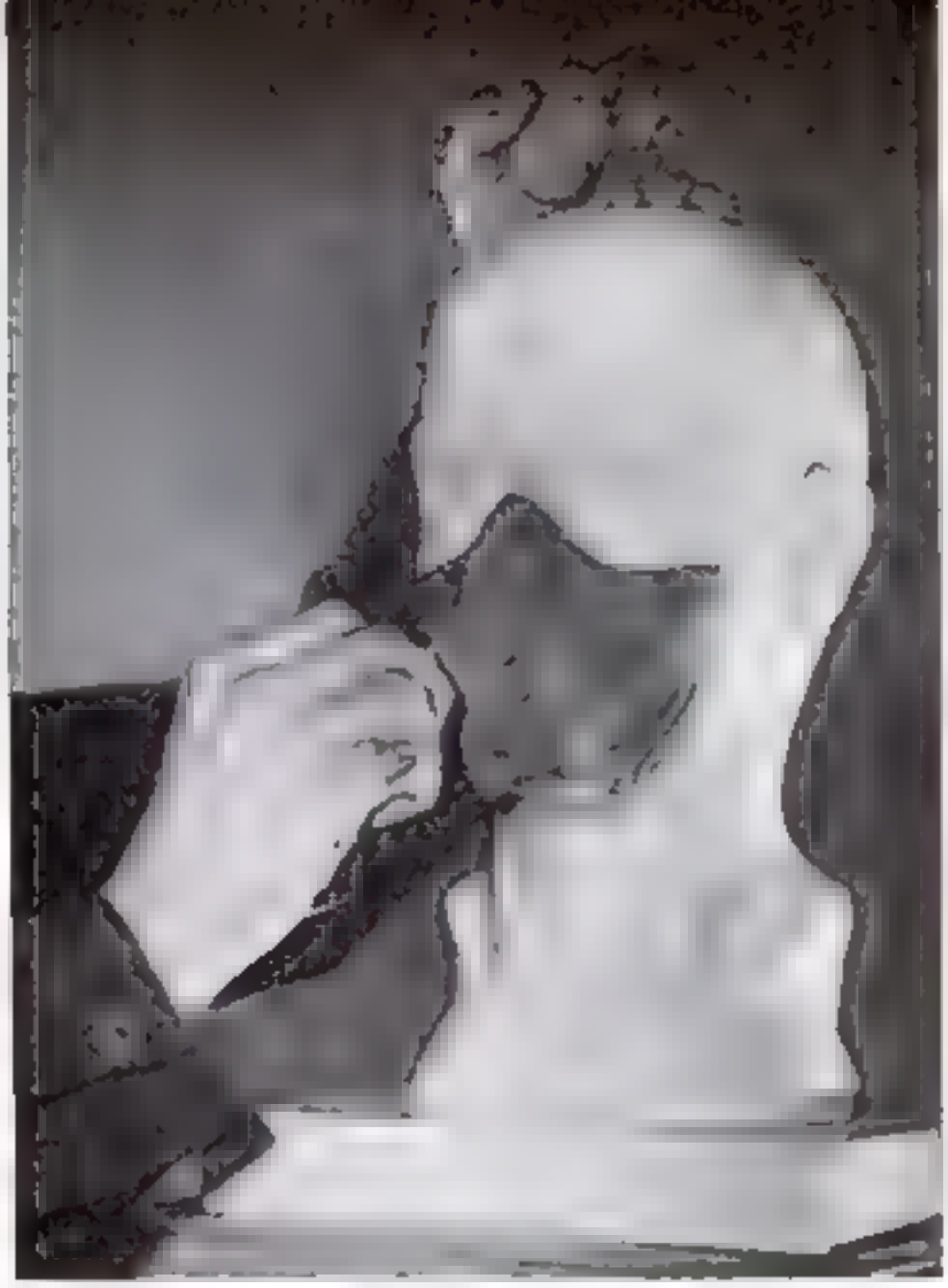
Dominant among the seven heads is the central figure, designated as Head I, representing the average flyer, the grand mean of all the measurements taken from the 1,871 specimens. By luck rather than by artistic intent, he turned out to be the best-looking one of the lot, with a strange resemblance to both the Prince of Wales and the Arrow Collar Man as they appeared in the early 1920's. As the composite of the youngsters who have just lately been getting their wings, he is the American Flyer: 1943 Model.

The creation of these heads, which is merely the first step in the building of life-size manikins embodying airmen's physical characteristics, represents a fortuitous blending of practical engineering and pure science. They are the result of the collaboration of the young man who is probably America's foremost expert on the anatomy of the gorilla, and the plastics-industry pioneer who invented the "Frank Buck hat," now the standard tropical helmet for the American and British armies.

By last July, when the statistical analysis of all the measurements was complete, the anthropology team had dwindled to one man, now a second lieutenant in the Air Forces, 29-year-old Dr. Francis E. Randall, from New Philadelphia, Ohio. At Western Reserve University, Randall had specialized in comparative anatomy, working with Prof. T. Wingate Todd, who had the greatest collection of gorilla skeletons in this country. When Todd died, Randall continued his work. When the Japs struck at Pearl Harbor, he was just putting the finishing touches on his Harvard Ph. D. thesis, on "Growth in Gorillas." One gathers, talking with him, that Randall felt pretty much out of things, as though his specialty were far from wartime realities. But no sooner had he finished his studies than the Army grabbed him, to put his special training to work on the quest for the perfect mask.

When Lieutenant Randall presented his report last summer, senior officers looked at it with a blank, bewildered stare. It comprised numerous closely typed pages of little else but figures, about as intelligible as Egyptian hieroglyphics.

"Now you've got it, what are you going to do with it?" a general finally managed to say.



Designing an impromptu mask for one of the head models in the set of seven made to measurements that will fit the entire range of faces in the Army Air Forces. In stratosphere flying it is important that the oxygen masks allow no leakage

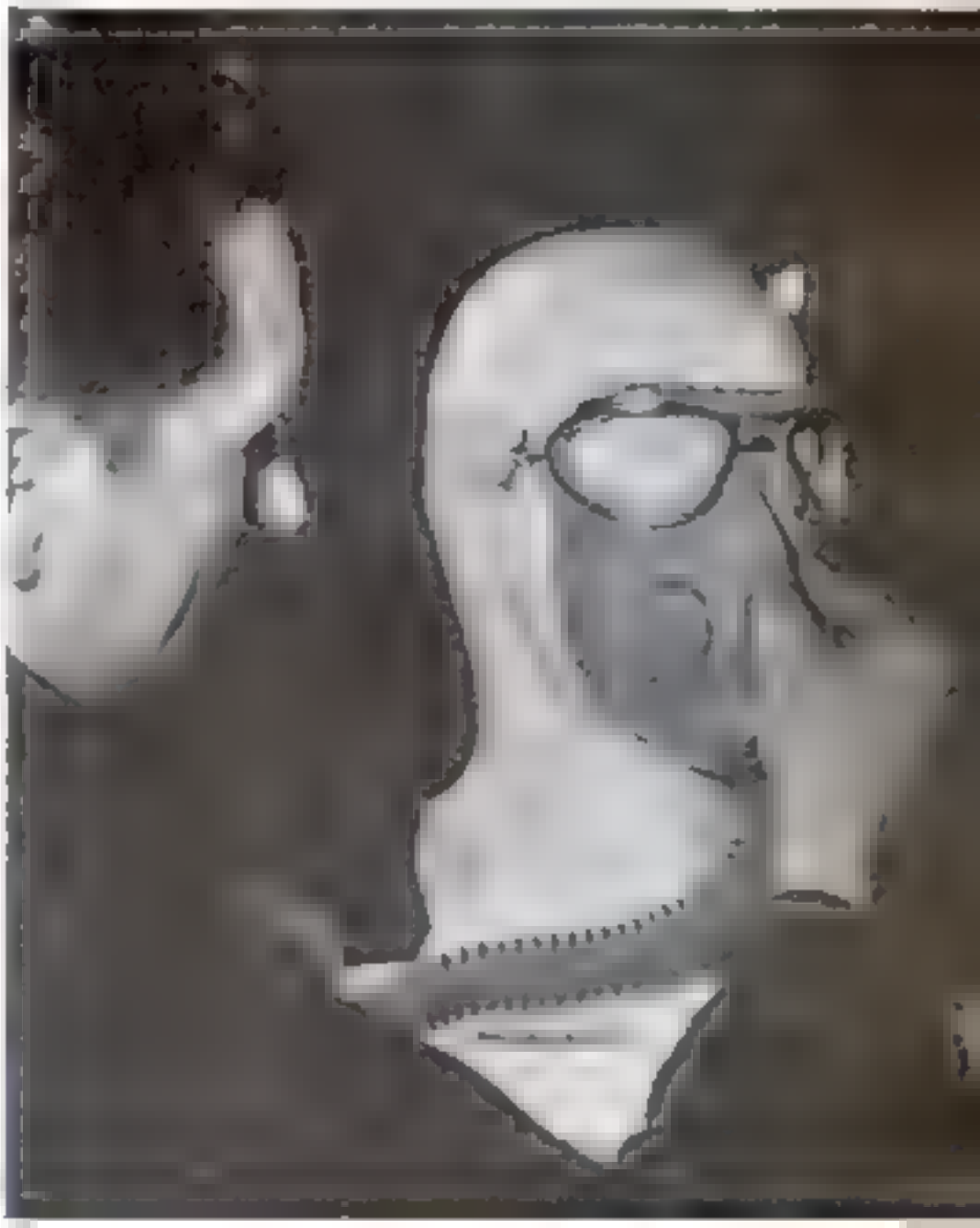
G. Walter Borkland, head of a plastics company and designer of many oxygen masks, fits this one to the contours of the model face. He made the original clay models of the heads themselves to the measurements furnished by Lieutenant Randall

The men at Aero-Medical had a quick answer. Turn these figures into sculptured figures. The value of such figures was already apparent. At Wright Field they had been using, as a model for trying out assemblies of mask, goggles, earphones, and helmet, an aluminum head which a sculptor had made for the purpose. It was a good, anatomical head of an individual, but measurement now showed it to be far from the norm of the Army aviator of today. The thing to do was get a sculptor quick.

A noted sculptor was called on the long-distance phone. How quickly could he produce five heads, made to measure? The artist said it would take at least two months; he couldn't do it a bit sooner. The Army reluctantly said he wouldn't do. They had to have speed.

Then a Wright Field engineer spoke up. He knew a business man in Chicago who he thought could do the job, G. Walter Borkland, president of the General Plastics Corporation. As a sculptor Borkland was only a talented amateur, who practiced the art as a hobby, but he was a professional with modeling clay. He was in the habit of designing such things as transparent plastic lighting fixtures, rapidly and strictly to specification. He was ingenious, as shown by his develop- *(Continued on page 223)*

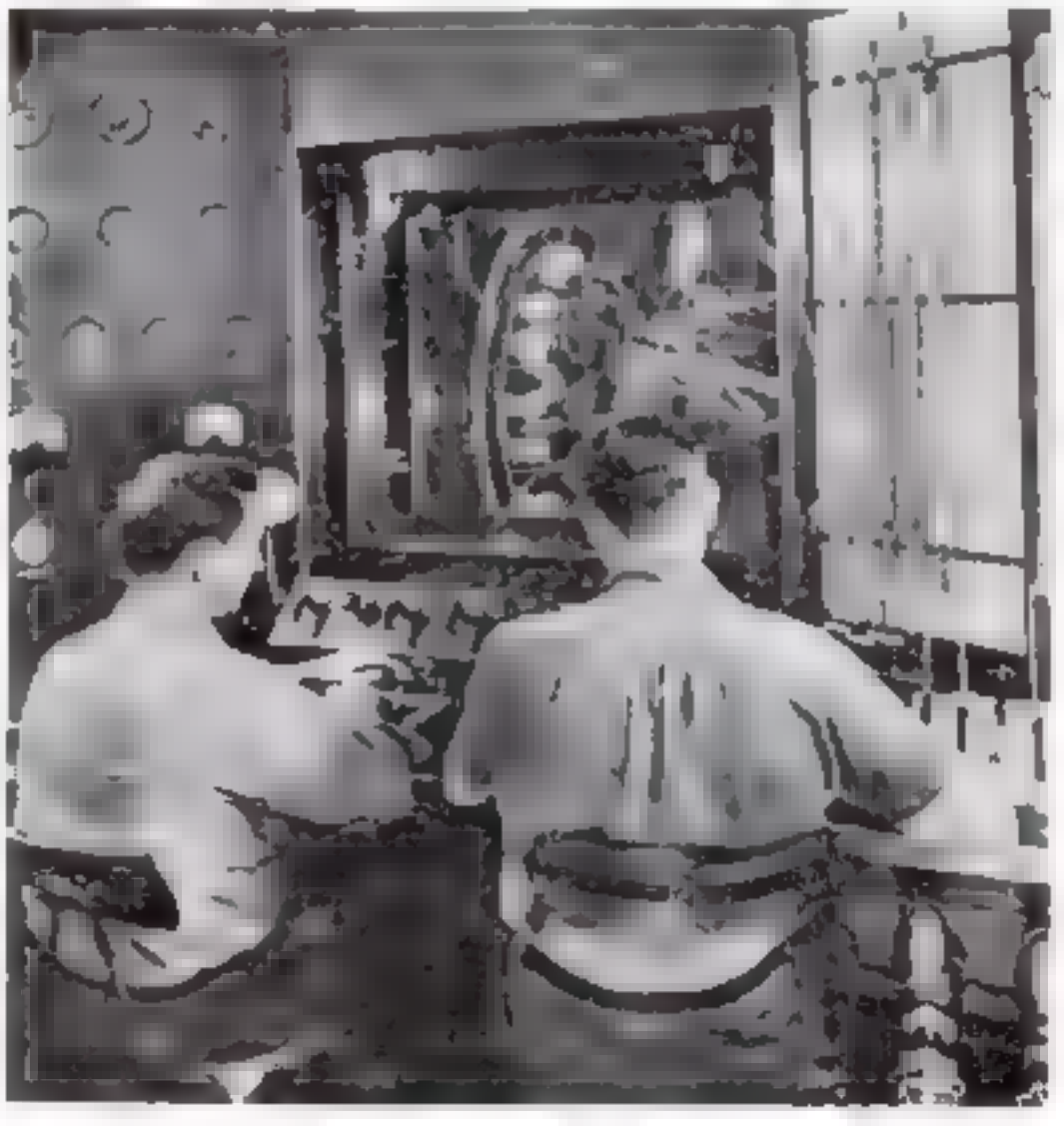
And now the finished mask covers the entire face up to the goggles, a precaution against freezing cheeks in sub-zero temperatures. It has space for a microphone, and is also provided with an escape valve over each cheek for the exhaled air



AIRPLANE CONTROLS can now be studied, and their operation quickly learned, with the scale model shown at the right. Here an aviation student at Franklin and Marshall College, with his hand on the "stick" and his feet on the "pedals," puts the model through precisely the same maneuvers that he will have to perform in an actual plane. Although he may have had considerable "blackboard" training up to this point, it isn't until he gets his hands on the model that he sees for himself exactly what happens to the plane when he manipulates the controls. Besides helping him in the essential factors of timing and co-ordination, the model plane does something even more important—it gives him the "feel" of a plane.

TEST RUNS on new Pratt & Whitney airplane engines are now being utilized to generate electricity in one of the company's New England plants. By means of equipment developed by engineers of the company and General Electric, the engines, instead of turning propellers during their testing, now turn generators and pump electricity into the plant's power system. Lines run from the engine to dials and indicators in a soundproof room where operators study the readings to determine performance.

PLASTIC SCABBARDS for bayonets, which will help to lighten a soldier's equipment, are now being issued to U. S. troops in all parts of the world. Made of Tenite, a plastic material made from cellulose acetate butyrate, the new scabbard, besides being light, is tough and durable, and comes as a welcome replacement to the old scabbard which was made of leather and wood. It conforms in every detail to Army requirements, and can stand hard service in any climate.



HANDLEBARS attached to a .50 caliber antiaircraft machine gun make firing the weapon seem much like riding a bucking motorcycle at high speed over a bumpy road. The photograph at the right, taken on a patrol vessel somewhere on the Pacific, shows a steel-helmeted Coast Guardsman in action.

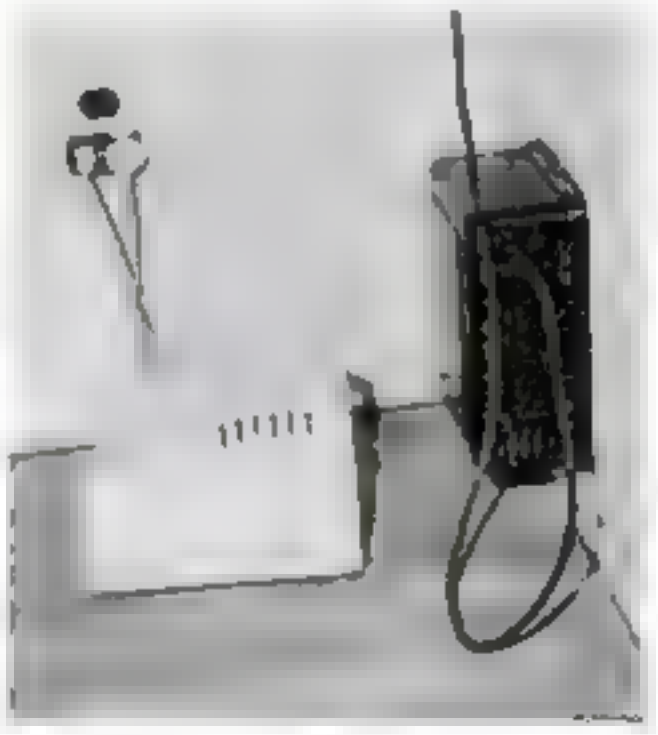
As compared with aiming by a shoulder rest, the handlebar grip is said to be less fatiguing to the gunner, since the bars absorb some of the vibration of the gun. It also allows better leverage and freer sweep for following fast-moving planes across the sky.

The trigger mechanism is operated by means of a squeeze grip on one of the handles, just as the throttle of a motorcycle is controlled by one of the rider's hands.

A Coast Guardsman "rides" a machine gun on patrol in the Pacific. The antiaircraft weapon is aimed by means of handlebars

RUBBER FROM THE FARM has become a reality with commercial production of Agripol by Reichhold Chemicals, Inc., Detroit, Mich. Made from soybean oil and ethyl alcohol, the chemurgic rubber is not now offered as a substitute for natural rubber in automobile tires but will be used for many industrial and domestic purposes. Clinton Braidwood, one of the developers, is shown with a sample of Agripol. Before him are jars of the ingredients and lumps of raw rubber made from them.

AIR-RAID WARDENS and other civilian-defense workers have enlisted an "electric sentry" manufactured by the Zenith Radio Corporation to listen for urgent telephone calls. A transmitter unit plugged into an outlet near the phone, as below, relays the ringing of the bell to a receiver unit plugged in anywhere about the house



THE "SENTINEL" is the Army's latest fast-climbing, highly maneuverable liaison plane. Capable of landing in or taking off from a cow pasture, it has been designed to hover at low speeds so that its observer can "hang" in the air to direct artillery fire and troop movements by radio.

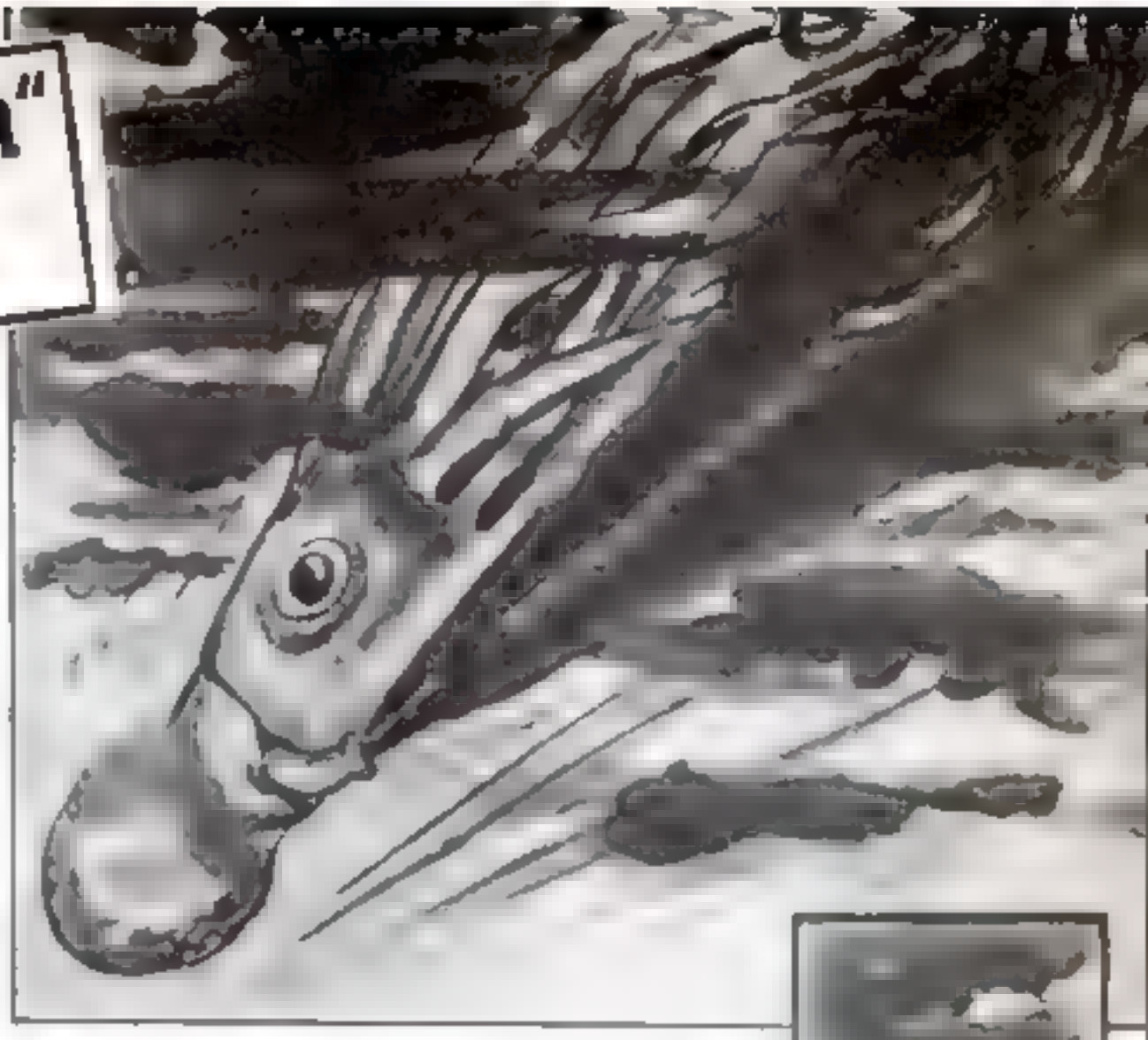
UNDERGROUND production of aircraft is speeded up in this British plant by means of a tiny railroad which carries parts from one shop to another. Visiting American plane builders are shown getting a ride.

COMMAND BOATS for use by the Army in the landing of invasion forces are one of the many types now being turned out by Chris-Craft. 42 feet long, and particularly seaworthy, the boat carries guns fore and aft, and has been especially designed to meet all requirements of transporting officer personnel.

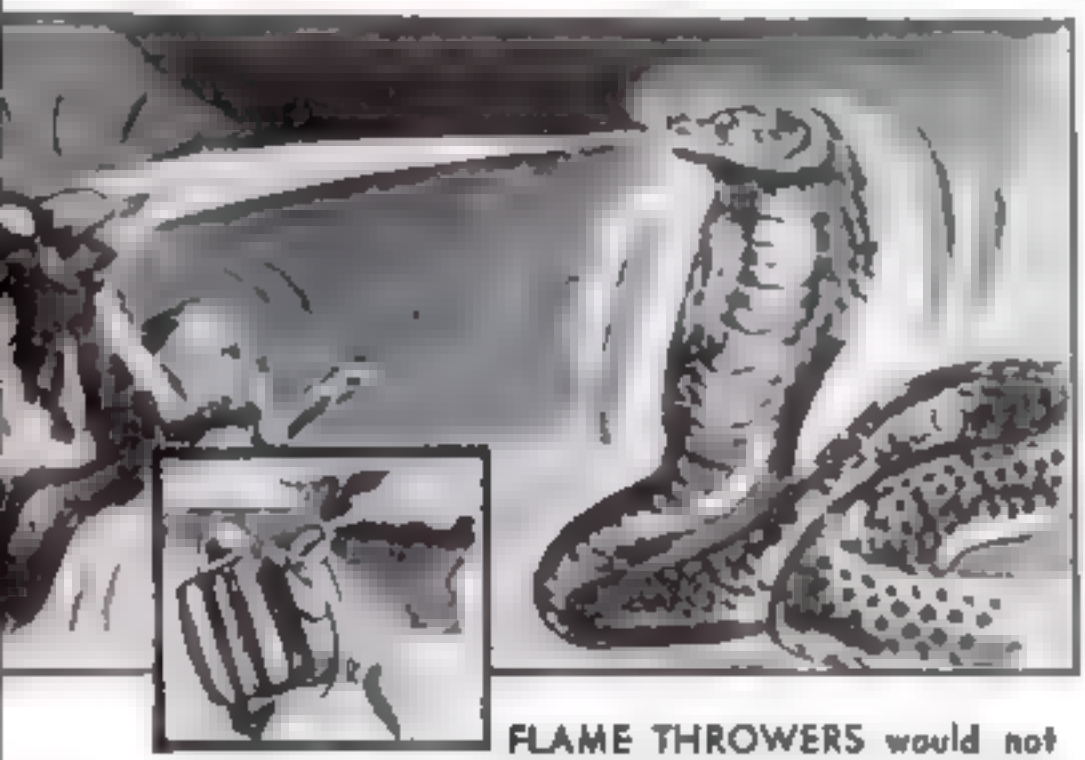
Nature's "Modern" War Weapons

Drawings by Gus Mager, based on an exhibit at the American Museum of Natural History

MOTHER NATURE was the first war inventor. To protect her creatures against their enemies, or to help them hunt their prey, she has provided them with weapons and tactics that in many cases anticipated the vaunted "new weapons" of modern human warfare. The skunk was a past master of chemical warfare long before men ever thought of using gas to demoralize their enemies; warring ants display organization worthy of larger belligerents. In many weapons man has consciously copied nature; in others he has arrived scientifically at results she achieved through evolution.



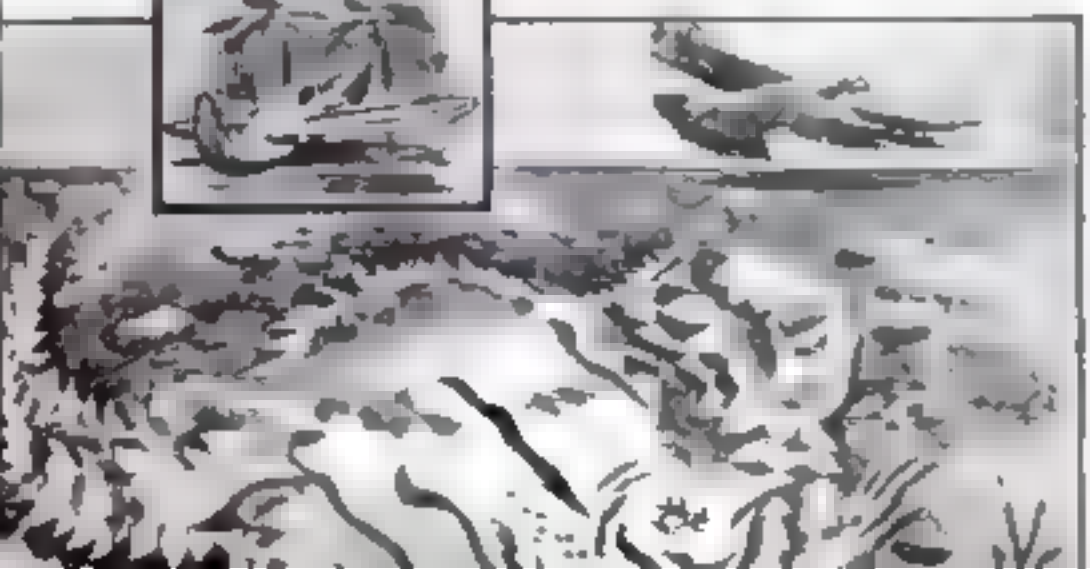
SMOKE SCREENS are old stuff to the octopus. When he finds himself in a tight spot, he ejects a fluid that clouds the water and allows him to maneuver unseen. Use of smoke to hide the movements of naval vessels or ground forces is merely a human adaptation of this old trick



FLAME THROWERS would not impress the cobra. He squirts his venom into the eyes of any unwary fox or other animal that molests him. One squirt is usually enough

AIR-RAID SHELTERS are improvised on the spur of the moment by lizards, which burrow into the ground when feathered Stukas dive after them in search of a meal

CAMOUFLAGE is one of nature's favorite stratagems. Lizards, birds, and other creatures are marked to match the ground or vegetation in their normal habitat. Man can learn many tricks from them



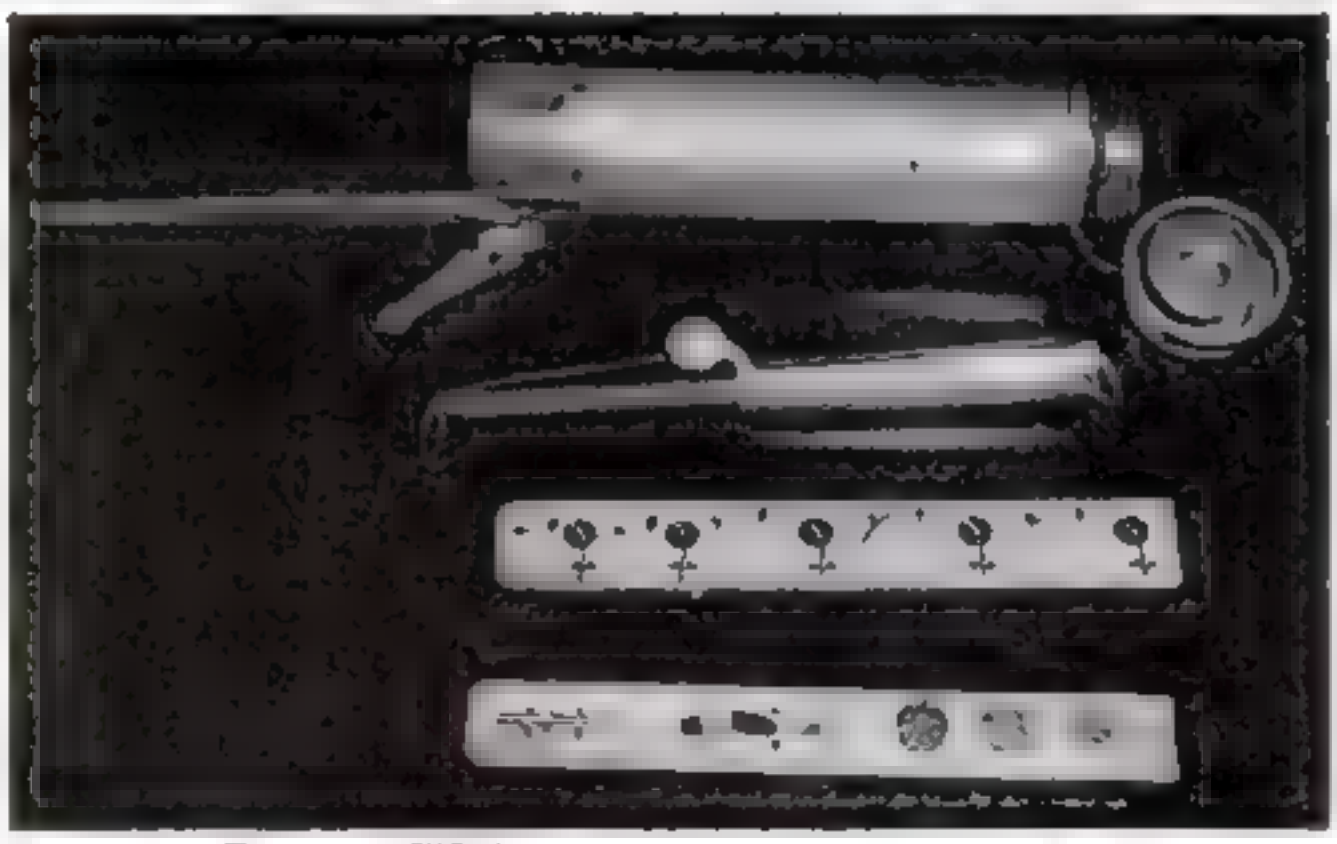
ARMOR PLATE on tanks and other war machines is a direct steal from old shellbacks such as the turtle. Even the lines of his one-piece, rivetless turret could serve as a model for a modern juggernaut

Stitcher Speeds Surgical Sutures

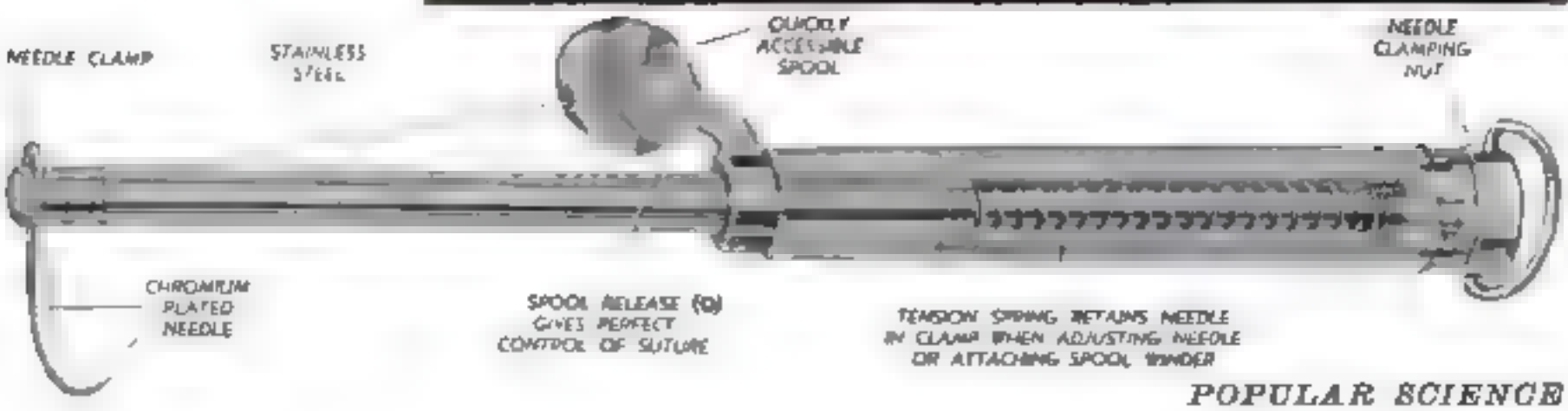
AN ADAPTATION of the sewing machine's "uninterrupted thread supply" to surgical suturing has resulted in a new stitcher that cuts precious minutes from operating time and eliminates the danger of spreading infection. The secret of the instrument's speed is that the needle can shuttle back and forth without stopping for fresh thread with every stitch. When it is inserted, the needle is driven in only far enough to allow the surgeon to catch the loop of the suture, so that no part of the thread is needlessly contaminated. The surgeon then knots the thread, snips it with the sharp lance point of the needle, and, with a slight pressure of his thumb, releases sterile thread for the next stitch.

A novel feature of the suturing unit's metal container, which has been designed for military use, is a bayonet that can be extended from the side of the case and driven into the ground. The surgical stitcher was developed by the Singer Sewing Machine Company.

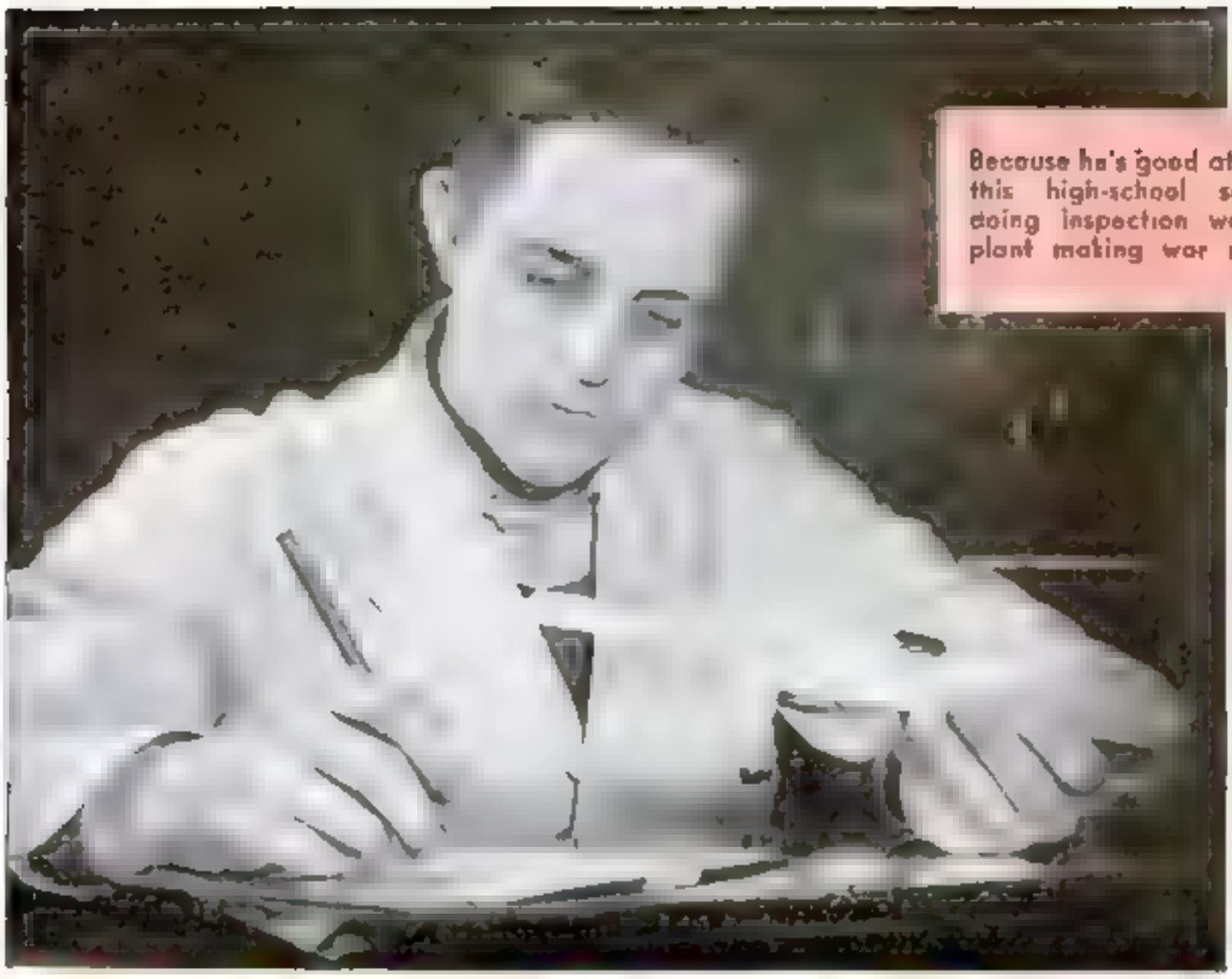
A wide variety of sutures can be performed with this "double-eyed" needle. At the upper left is shown a "continuous" suture; at upper right, an "interrupted" suture



At right is the suturing unit complete with needle holder, needles, spools for the thread, and the metal case with its bayonet attachment. Below, a diagram view of the new instrument



POPULAR SCIENCE



Because he's good at "math," this high-school senior is doing inspection work in a plant making war materials

War Drafts Young Scientists

YOUTHFUL student scientists are now getting a real break at the Alexander Smith & Sons Carpet Company in Yonkers, N. Y., largest carpet manufacturers in the world. Looking ahead to the time when their technical personnel would be reduced by war demands, the Smith company last summer began employing, as "junior specialists," Yonkers High School seniors who had shown a marked proficiency in science courses. The aptitude that these 17-year-old students—four boys and one girl—have shown in jobs of physical and chemical testing has surpassed all expectations, and the company now plans to make use of additional students in other types of scientific work.

One of the reasons the youngsters get such a kick out of their work is that, aside from their own scientific interest, they realize that the materials they are testing will be used to make canvas duck and blankets for our fighting men all over the world. Another reason is that they don't get a chance to get bored, for the company periodically shifts them from one job to another, the theory being that they are to be given a broad, general training in laboratory procedure.

The only hitch to the plan is that these young scientists might be drafted. But as the authorities point out, what they learn now will help them when the war is over.

Another Yonkers High School student, Rebecca Moskowitz, learns how to make microscopic inspection of rayon fiber

Ready to shoot—with film or Tommy gun. Part of the crew of one of the Army's new mobile photo assignment units atop their carryall. Specially trained crews like this are with our troops on all fronts

Studios on the Battlefield

DAREDEVIL CAMERAMEN SHOOT HISTORY'S MOST PHOTOGRAPHED WAR

By JACK O'BRINE

CAMOUFLAGED machine-gunners wriggle to the edge of a thicket and peer into a clearing below. We see their faces at close range—strong, alert faces with the same purposeful glint as their guns. Then we get a view of the other side of the small valley where a second machine-gun detachment is crouching among the trees. The men strain forward, fingering the triggers of their guns. A big, heavily armed reconnaissance car crawls into the clearing, and is immediately enveloped in a crisscross of machine-gun fire. Its occupants slump. Several tumble to the ground. The car jerks to a halt, and the two ambush parties take over. The image fades; another "war picture" has ended. But this is the real thing. Thanks to some unsung newsreel hero, we have glimpsed a distant battle scene from the safety of an air-conditioned American theater.

We pick up our morning newspaper. Black headlines tell of a new offensive, and there before our eyes rises the smoke of battle in a four-column picture. A photographer was on the job. A big warship is attacked and battered into a flaming mass of steel. There it is before us. We see our own tanks blasted and blasting the enemy; we see our own planes roar over their targets; we see enemy planes attack and fly away, or fall smoking from the sky. Lensmen inside and outside of our armed forces are risking their lives daily to show us what's going on.

This is the most photographed war of all time. In the first World War we were lucky to get views of our troops marching off to war, of our convoys sailing, of generals meeting far behind the front, of Y M.C.A. doings and Red Cross parties. Once in a while we saw a picture of some shell-shattered buildings, but never did we get a picture of actual combat. That last touch of

One of the greatest pictures to come out of the war is this shot made by a fighting U S Navy photographer at the height of the sneak Japanese attack on Pearl Harbor His lens caught the destroyer Shaw as her magazine exploded sending billows of flame and rocket like streamers into the smoke black sky

Another remarkable Navy picture shows the tanker Saga soon after the torpedo of an Axis submarine set her ablaze in the Atlantic. The fire was later brought under control but not before the aerial camera had recorded the scene Naval photographers are documenting history's greatest clash of sea power

On the Russian Front: a Red Army photographer risked his life for this shot of a high-powered rifle blasting a tank

U. S. Marines about to land in the Solomons. A newsreel man attached to the expedition got this view of the convoy as it approached Guadalcanal with crews manning guns and men ready to go over the side

One of the most remarkable amateur photographs of the war shows the scuttling of the German pocket battleship *Graf Spee* off Montevideo on December 17, 1939. The end of the marauder was snapped by a passenger aboard a neutral vessel that happened to pass the scene shortly after the German commander, Capt. Hans Langsdorff, had stood in a launch and set off the explosion with an electric switch

realism was saved for the fighting forties.

Behind the film front of World War II is a story of courage and cunning, skill and sacrifice. Hitler was the first world leader to discover in films a new weapon of war. Some of our cameramen saw his plan in embryo while they were covering the 1936 Olympic Games in Berlin. They stumbled upon it in looking up German cameramen they had known in America. Inquiries brought out the amazing fact that 120 of the Reich's best lensmen were living at the same address under military conditions and taking orders from Hitler's official cameraman, Leni Riefenstahl. These Germans formed the nucleus of the force of 500 cameramen that Hitler sent to the front when the war started.

Great Britain was slow to realize the importance of the new weapon with which Hitler began terrorizing neutral countries and emitting propaganda barrages. While the Germans were shipping off thousands of feet of film laden with sadistic, nerve-freezing attacks of dive bombers and tanks, the British were content to distribute films of troops behind the lines in France, drilling and playing football. When Britain decided to send an expedition to Norway, only one cameraman was permitted to go along—one man to film a continental expedition of the British Army—whereas 32 cameramen had been assigned to cover the Grand National Steeplechase!

But Britain learned—and so did the United States. Today our film coverage of the war has surpassed that of the Nazis. In the air, on land, and on the high seas, our cameramen and photographers are in action, and their films are making a thrilling record, an astounding informative pattern of war for our military leaders and our citizenry.

Soon after we got into the war, American newsreel and news-picture agencies worked out their plans. Co-operating closely with the War and Navy Departments, the agencies formed pools to receive and distribute not only the films of their men in the field but also those of the growing corps of Army and Navy photographers and cameramen and those of our Allies. They arranged with Washington to send men to all the far-flung fronts to which our fighting men were going. The pools were set up in New York—the Roto Pool (for still pictures) and the Newsreel War Pool. Now into the two pools go all photo material of the war for

On the beach at Guadalcanal. Here the newsreel man turned his back on Japanese snipers and machine-gunners to record the historic scene as Marines swarmed ashore from landing boats to seize the beachhead on the island

This Is the Army's Mobile Photo Unit

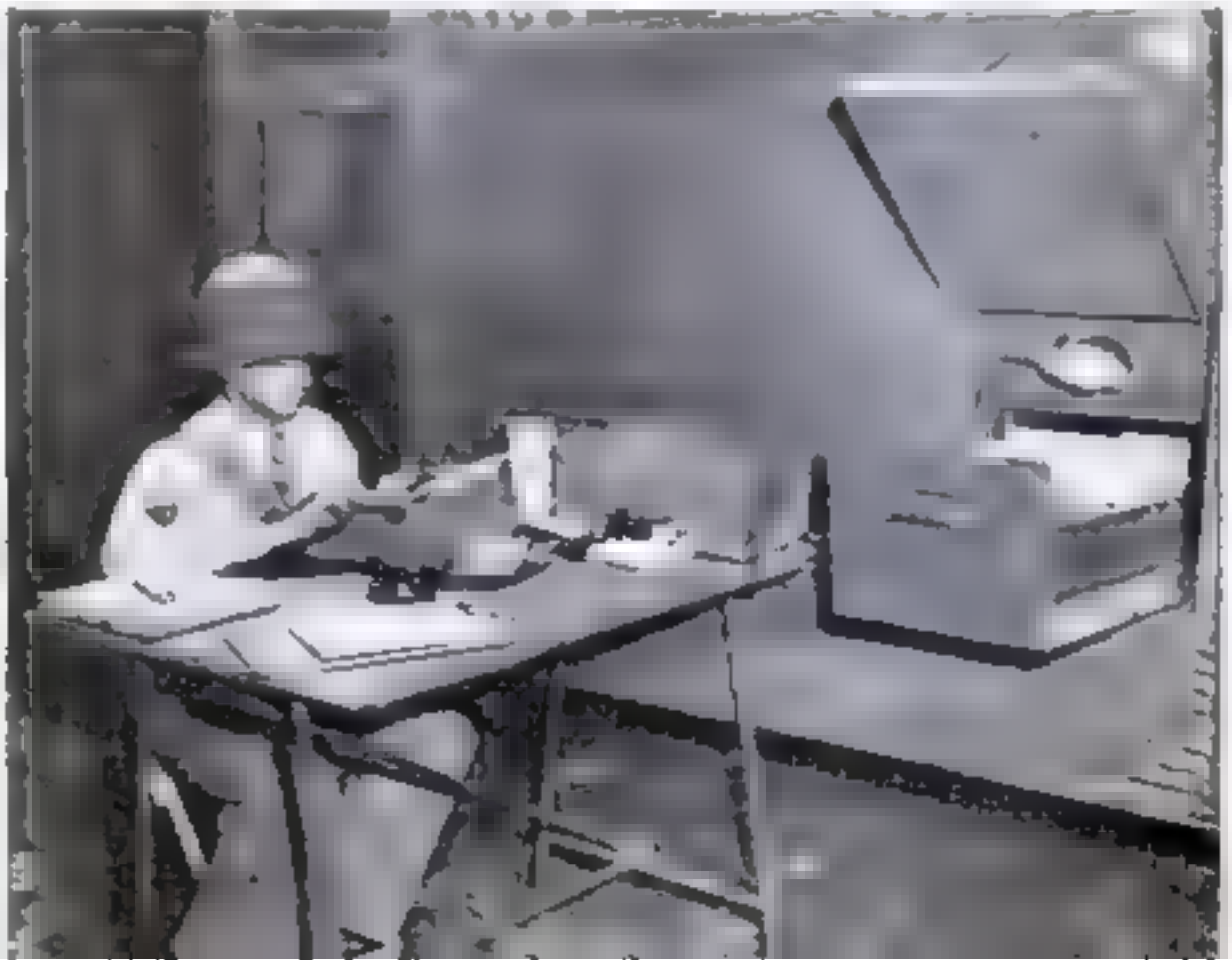
Here is the Army's answer to the demand for close-up pictures of our fighting men in actual combat: a complete and self contained photo assignment unit as set up by the Signal Corps. Personnel consists of a motion-picture cameraman and assistant (1, 2); man with 16-mm. camera (3) to supplement the 35-mm. films of the tripod job; two still photographers equipped with Speed Graphics (4, 6); lieutenant (5) commanding the unit, with a miniature camera for still pictures; and a driver (7) who does his shooting with a Tommy gun. The carryall provides transportation and a camera platform

An Army photographer adjusts the synchronizer on his Speed Graphic while waiting for an assignment. Note his helmet and Tommy gun

Returning from picture tasks, lensmen turn their film holders over to a worker in the company's trailer laboratory. Here the films are developed and prints are made

Making a contact print. Other equipment, designed for compactness makes enlargements when necessary

Record clerk works with a typewriter at a collapsible desk set up beside the trailer. A filing cabinet drawer slides from an opening in the outside wall of the laboratory and an awning forms a roof



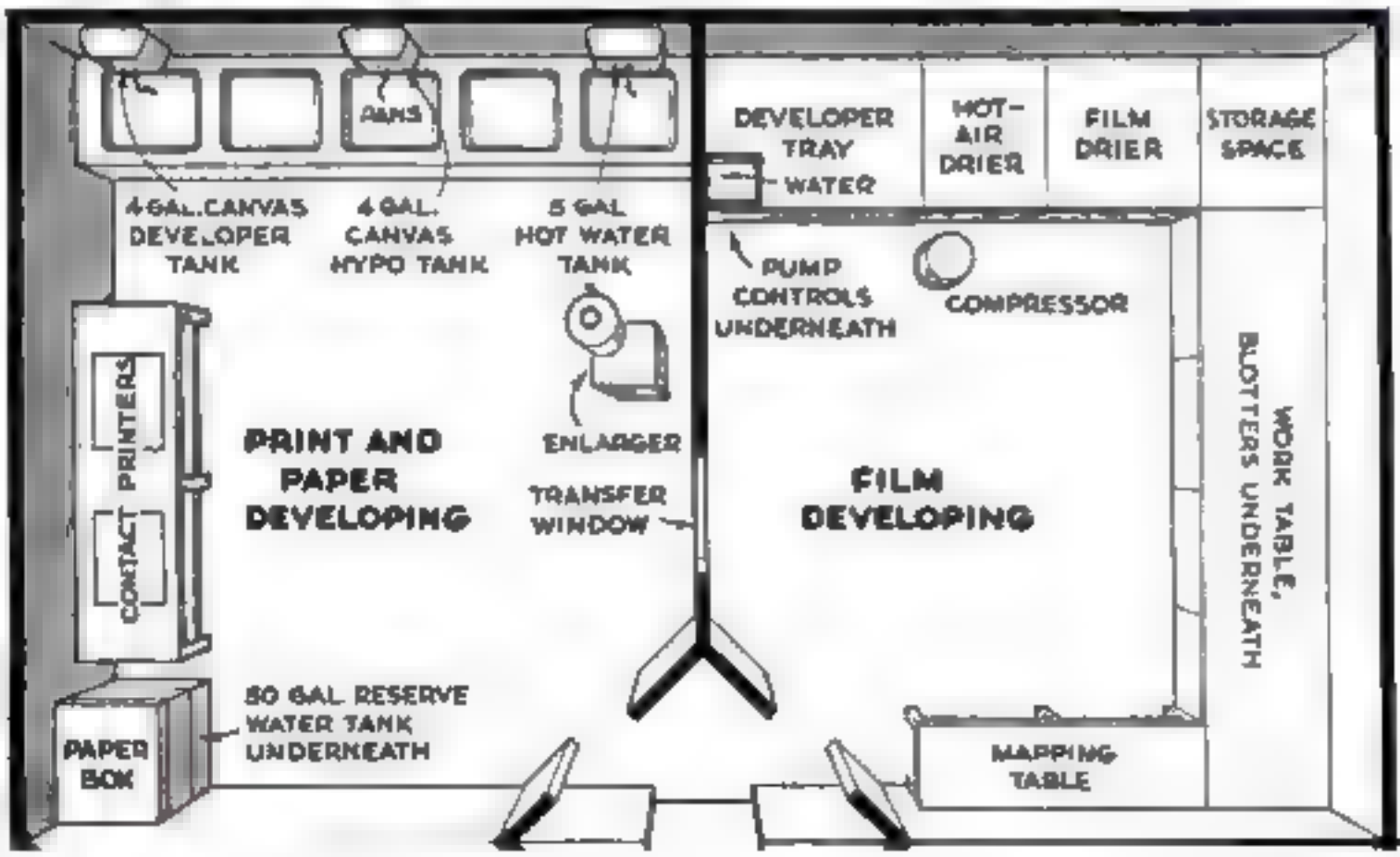
An Army enlisted man photographed this action scene of a 75-mm. howitzer landed from a transport plane going into action in support of U. S. paratroops on an airfield. Note how the camera caught the belch of smoke as the piece was fired. Pictures like this are of immense military and historical value

immediate public showing, once the censors have given the green light. Members of the pools share the expenses of keeping men at the front and divide coverage equally.

Charter members of the Roto Pool are Acme, International News Photos, The Associated Press, and *Life* Magazine, each of which has seven photographers in the field. But the pool is open to any photo agency, newspaper, or magazine meeting the requirements, chief of which is to share coverage expenses. Insurance is one of the most costly items, amounting to as much as $1,200 a year per man. Other expenses, including equipment, supplies, living costs and uniforms, bring the total to about $80,000 a year for each member—a small price for the superb pictures obtained.

Civilian war photographers and cameramen are given the same rating as war correspondents, once they are assigned to a combat unit. That is to say, they enjoy the privileges of officers. They must be accredited in Washington before they are eligible for duty abroad, and they lose their civilian status to the extent at least that they are subject to the orders of the military or naval command to which they are attached and must accompany it into battle or wherever it goes, unless ordered to do otherwise.

(Continued on page 216)



Floor layout of the Army trailer photographic laboratory. One of these will serve a photo company, which may include a dozen or more assignment units

new Tools

DIRECT READINGS are possible with a new caliper for machinists, which measures down to 1/32 of an inch and has a maximum capacity of four inches. Its white scale markings on a black background are easily read even in a poor light, and the simplicity of its operation makes it an accurate and speedy tool to use. Design is such that measurements can be made over a head or rim.

A CAM-ACTION LEVER LOCK, which quickly sets up or releases the blade of this hack saw, makes it possible to replace or reposition blades in a fraction of the time required in frames of ordinary design. By pulling out a pivot pin, sliding the frame's forearm in or out as desired, and then snapping the pin back into place, the frame can be adjusted to 8, 10, or 12-inch blades. Positioning the blade in any one of four directions is done by placing the blade over either of two sets of fixed pins.

TACK-WELDING SHIPS' PLATES is simplified by an electromagnetic machine for holding bulkhead stiffeners to the plates during the welding process. Tack-welding ordinarily is an involved procedure requiring the use of U-shaped pieces of metal called saddles which are welded to the plates and then later must be ground off. By eliminating the saddles, the new machine, designed by an employee of an East Coast shipyard, has reduced the time of this phase of construction by 50 percent. The stiffener, shown lying horizontally on the floor, is straddled by the electromagnet, which lifts the steel plate to the desired height and holds it there for tack-welding. After one section has been welded, the machine moves down the stiffener on rollers and the process is repeated. Lowering and raising the magnet is controlled by a large handscrew.

How To Fight The New Explosive Incendiary

A NEW type of incendiary bomb carrying a delayed-action explosive charge, now being used extensively by both Germany and Japan, has made it necessary for the Office of Civilian Defense to revise its instructions on fire fighting. Because it is impossible to tell when the bomb will explode—the time fuse can be set to ignite anywhere up to seven minutes after the bomb has struck—it is necessary to use the greatest caution in fighting the blaze which is set immediately on impact. Instead of water sprays, sand, scoops, grabs, and snuffers, a strong jet of water must be used. And most imperative, the user should be behind a four-inch brick wall, or other barrier equally strong, to protect himself from the bomb's powerful fragmentation. Water is the best agent for combatting this type of bomb, and civilian defense authorities are emphasizing the need of keeping adequate supplies on hand. Hot-water tanks, or storage tanks for water heaters, can be used provided they can be drained quickly. Once the bomb has exploded, sand, sprays, and other means formerly advised, can be employed to extinguish the fire.

A charge of high explosive with delayed-action firing mechanism presents a new hazard to civilian-defense men in the new bomb

Dropped in clusters from containers, incendiaries scatter over factory or residential areas. Fighting technique, illustrated at right, calls for the use of jets of water applied from behind a brick wall or similar barrier

Jane Frazee is no chemist, but she knows ink stains can be removed by soaking the material in raw milk, or in tomato juice that has been boiled in a little water for 10 minutes

YOUR CLOTHES HAVE TO LAST LONGER NOW—AND IT WILL HELP IF YOU KEEP THEM SPOTLESS. HERE'S HOW TO DO IT:

By ANDREW R. BOONE

Photographs posed by Jane Frazee, Universal Pictures starlet

ABOUT your clothing and other textiles around the house: better keep 'em clean. Most of them must survive the war, because goods of that sort are disappearing from the market. So be prompt in cleaning them, for all stains, from blood to ink and perspiration, get tougher with age.

How should you proceed? Here are a baker's dozen of the most common stains. Try the remedies recommended, and you'll be surprised how well they work.

BLOOD. Never start by using hot water, because it will set the protein and multiply your trouble. On washable material, soak or rub the article in cold or lukewarm water until the stains become light brown. Then wash in hot water. If you prefer, soak washable material in a solution containing two tablespoonfuls of household ammonia to one gallon of water until the stains loosen. Then wash in the customary manner. Ammonia chases old stains better than soap. To get out the last traces, sponge the spot with hydrogen peroxide to which you have added a little ammonia water. Apply the peroxide with a medicine dropper or a glass rod, and rinse carefully to prevent possible destruction of the fibers, especially in cottons and linens.

BLUING. Most likely you are using a soluble variety of Prussian blue. This type of bluing reacts to alkali left in clothes unless they are thoroughly rinsed, and needs the same treatment as iron rust. To remove both bluing and iron-rust stains, spread the material over actively boiling water and squeeze a lemon over the stained area. This treatment, slow but sure, will not injure even the most delicate white cottons and linens.

Stains from ultramarine blue, which comes in balls or blocks, may be removed by soaking or rinsing in cold water. In persistent cases, laundering with soap will get them out. Heavy stains of this type will vanish if soaked in a 10-percent solution of acetic acid or hydrochloric acid diluted with four times its volume of water.

CANDY. Ordinary laundering usually is sufficient, but on nonwashable materials sponge with clear warm water. If this doesn't chase chocolate stains, stretch the material over a bowl and drop Javelle water on the stain with a medicine dropper. Make sure the Javelle water does not remain on the fabric more than one minute, after which apply a solution containing one-quarter ounce of sodium thiosulphate (hypo) and an eighth ounce of 36-percent acetic acid in two quarts of water. Then rinse well.

Grease solvents will take out the fat content of the stain from nonwashable fabrics, while the remainder may be removed by hydrogen peroxide. Soaking the stained portion of a washable fabric in wood alcohol

Home Spotter's Guide

made alkaline with ammonia solution is particularly effective. Should any dye remain, soak the material all night and dry it in the sun. A hydrosulphite, available at the drug store, is the most efficient dye chaser if properly applied. The hydrosulphites are effective on nearly all stains unless they are greasy, but should not be applied to colored materials unless they are handled rapidly and the material is rinsed well once the stain is removed. However, they may remove color from the fabric

COFFEE. On washable fabrics fresh stains and most old ones will disappear with ordinary laundering. If a slight trace remains, dry the material in the sun. Pouring boiling water on a fresh stain from a height of two or three feet is also effective. A solution of potassium permanganate, made by dissolving one teaspoonful of crystals in one pint of water, applied by a round-end glass rod and per-

She does a good job on hubby's Panama by brushing it with soapy water and ammonia, then rinsing and fan-drying it

THESE MATERIALS WILL MAKE YOUR CLEANING EASY AND THOROUGH

Javelle water
Potassium permanganate
Oxalic acid
Ammonia water
Carbon tetrachloride
Glass rod with rounded ends
Heat-resistant bowl
Pads of muslin
Medicine dropper
Small sponge
Milk, Lemon
Stiff brush
Corn meal, Talcum powder
White blotting paper

Either corn meal or salt will do an efficient job of absorbing grease—and they don't leave a ring

To clean a coffee stain, stretch the material over a bowl, apply a solution of potassium permanganate with a dropper, then let it dry for five minutes

mitted to remain about five minutes, will do a good job. The remaining permanganate stain can be removed by applying hydrogen peroxide turned slightly acid by adding tartaric acetate, oxalic acid, or hydrochloric acid, followed by a thorough rinsing. Lemon juice is an excellent cleaning agent for cotton or linen. On nonwashable wool, sponge with cold or lukewarm water and remove any remaining cream with a grease solvent such as ether, denatured alcohol, gasoline, or benzol.

FRUITS AND BERRIES. Stains of uncooked fruits and berries usually may be washed out by pouring boiling water from a height of three feet, so that the water strikes with some force. For this treatment, stretch the section taut over a bowl. "Cooked" stains, on the other hand, usually require different treatment. Try the method given above, and if necessary moisten any remaining stain with lemon juice and expose it to bright sunlight. Hydrosulphites are also satisfactory when dealing with white fabrics, and Javelle water works wonders on white cotton and linen, but not on wool or silk.

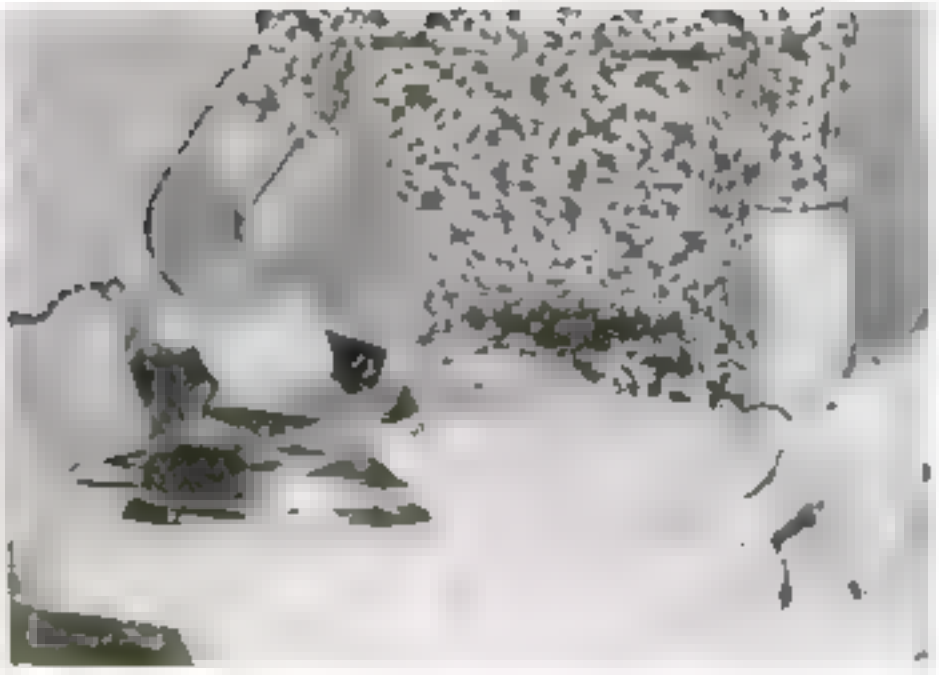
GREASE. This includes butter and other fats, with or without complicating dirt ingredients. First step, of course, calls for scraping off the surplus with a knife. Next, use either a soapy, warm water solution, an absorbent or a solvent. Soaps containing kerosene or naphtha are particularly good.

As an alternative, apply fuller's earth, white talcum powder, brown paper, corn meal, or chalk to absorb the grease. Corn meal and salt are particularly efficacious on rugs. These materials do not leave rings, as may water and grease solvents. If the stain does not wash out or absorb, however, you may try a solvent. Place a pad of clean cloth or blotting paper under the stain, and apply a sponge moistened with a solvent. Change the pad when it becomes soiled. Use small quantities of the solvent, and work in from the outside to keep the stain from spreading.

INK. If it is freshly spilled on the carpet, apply an absorbent immediately—talcum powder will do—working it around with a dull knife and brushing well after each application. When the dry material no longer takes up ink, make it into a paste and apply again. White garments may be dipped in raw milk. Tomato juice, boiled 10 minutes in a little water, is good; or, baking powder, followed by lemon juice.

MILK AND CREAM. These stains, as well as stains from ice cream, are similar, but may require slightly different treatments. Because milk consists largely of protein and fat, rinse washable material in cold or lukewarm water and follow this with hot-water-and-soap laundering. If the fabric may be injured by laundering, sponge with carbon tetrachloride, gasoline, or other solvent and then sponge carefully with cold water after

If a grease stain won't wash out or absorb, then try a solvent. Place a pad of clean cloth under the stain, and sponge well with naphtha or benzol



A "must" in cleaning is that you do a thorough job, for any remaining stain of blood, milk, meat juice, or egg will become "set" in the process of ironing

the spot has dried. Ice-cream stains also contain sugar, fruit flavoring, perhaps eggs, and frequently chocolate. Should a stain from these sources remain after the ice cream has been removed, clean them as you would fresh or cooked fruits, berries, coffee or chocolate. If the stain is not highly colored, wash with soap and water, or sponge. After it has dried, attack the stain as you would a grease spot.

PERSPIRATION. You may be unable to restore colors changed by perspiration, but hot water containing a little ammonia usually will take out the stains from washable materials. Soak the stained part in cold water for 30 minutes, then soak in hot water containing ammonia, and finally launder in sudsy hot water. Use less ammonia if the colors threaten to run. If you prefer, launder and bleach in the sun.

To remove fresh-fruit stains, first boil the material, then stretch it taut over a bowl of boiling water, and apply lemon juice. But be careful colors don't run. At left, an absorbent, repeatedly applied and brushed off, will clean blankets

America's new standard medium tank, the M-4. Heavily gunned, fast, and mechanically dependable, it is more than a match for anything the Germans, Japs, or Italians can send against it

WHY AMERICA'S TANKS ARE THE WORLD'S BEST

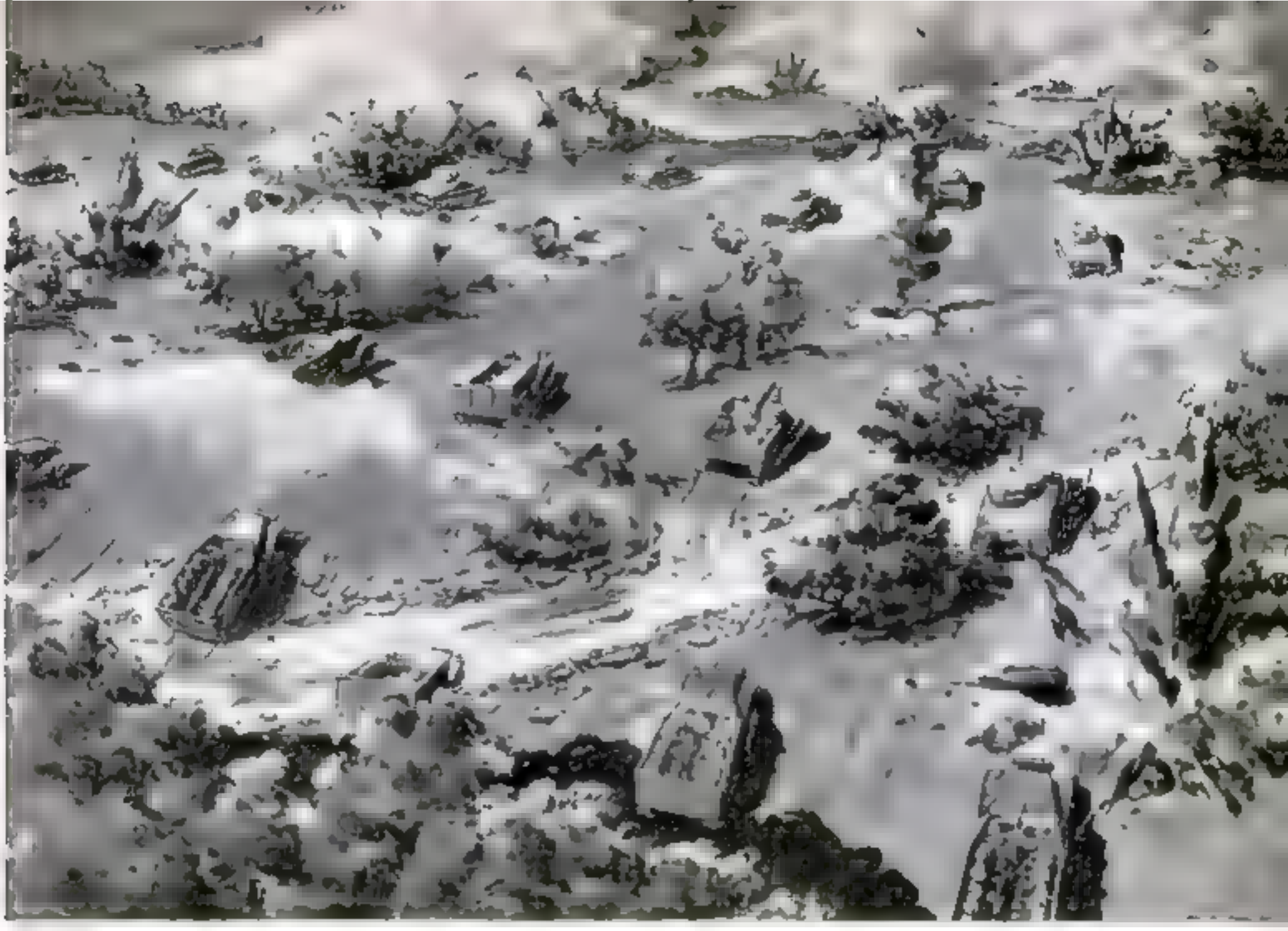
Guns, Speed, Armor, Durability —These Have Given Us the Lead on the Proving Grounds of War

By ARTHUR GRAHAME

THE battlefield value of a tank depends on three qualities: the power of its guns, its ability to take those guns where they can do the greatest possible damage to the enemy, and its mechanical durability.

In the fighting on the African desert which was climaxed by Rommel's rout, American light and medium tanks lend-leased to the British—a few of them handled by American crews—consistently outmatched German tanks of their classes in all of these qualities. Our 13½-ton light tank proved itself to be the hardest-hitting, fastest, and mechanically most dependable light tank on the vast and dangerous proving ground. Our M-3 medium tank, which the British call the General Grant, outshot, outspeeded, outlasted, and generally outperformed the German 18-ton Mark III and 22-ton Mark IV mediums which had been more than a match for the British Valentines and Matildas of the same respective weights.

As soon as they got into action, the American medium tanks proved that they had more powerful guns than the German fighting vehicles. They also proved to be much better than the German medium tanks for the job of carrying their guns and gun crews through heavy fire. Their superior speed and greater maneuverability made them harder to hit, and when they were hit the armor-piercing projectiles from

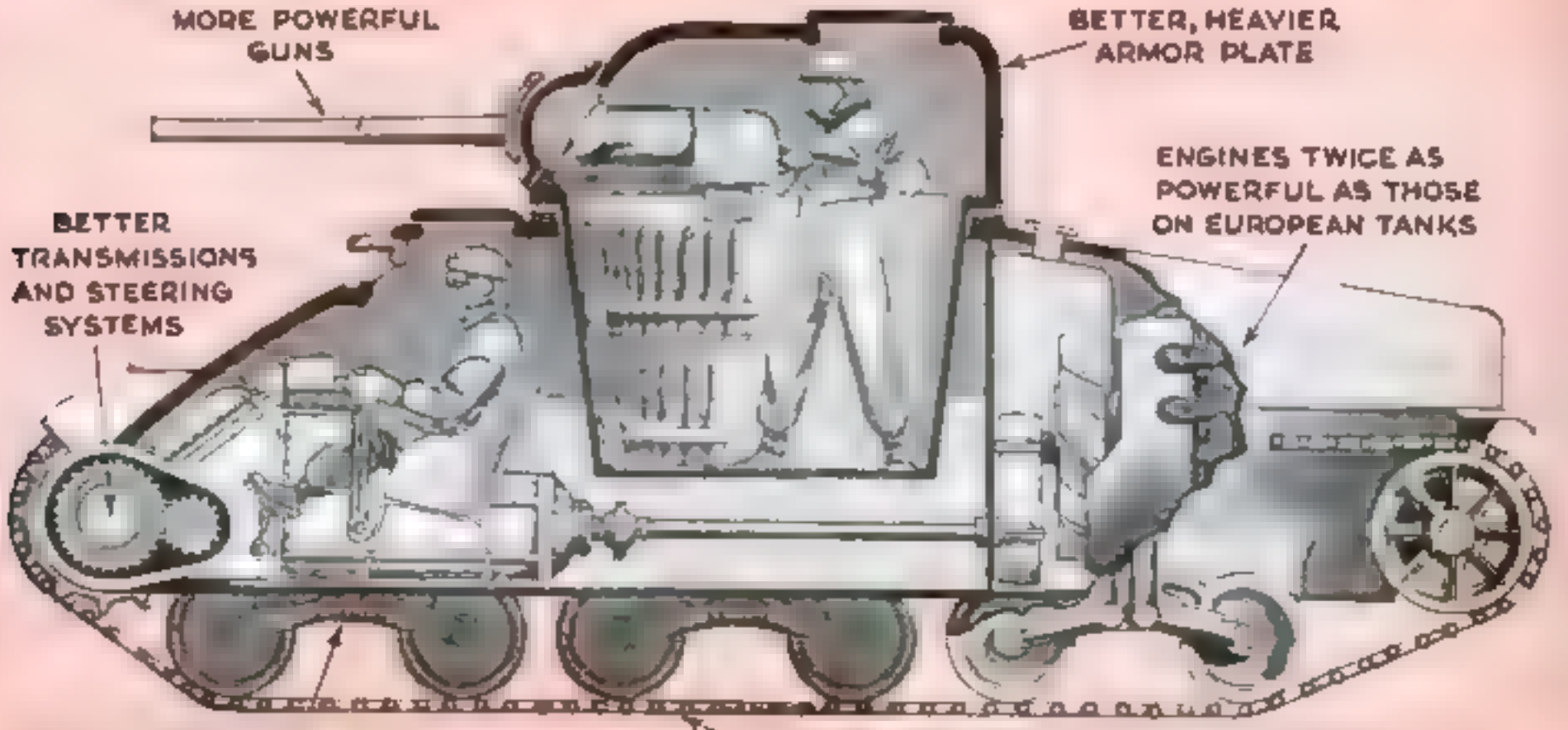


Tanks advancing with infantry following in carriers. This drawing, based on an illustration in the U. S. Army's Armored Force Field Manual for light and medium tank companies, shows an important use of tanks

the German gun-howitzers which had punched through the 2½-inch main armor of the British mediums had much less effect on their tougher and possibly thicker plates. Even the much-touted German 88 mm. high-velocity antitank guns weren't sure death to the sturdy General Grants one of which sustained eight hits by 88-mm. projectiles without being penetrated by them.

In mechanical dependability and durability our tanks were almost immeasurably superior to those of the enemy. Ninety of our light tanks went through an entire month of battle-front service with only 12 minor mechanical failures. A captured report of a German workshop company shows

HERE ARE SOME OF THE POINTS IN WHICH OUR TANKS EXCEL



It is bad business for advancing tanks to lay a smoke screen that will blow back on them. Drivers will be confused and tanks will be good targets

Smoke should be laid with the wind toward the enemy. As it drifts past the positions under attack, it will cover installations in the enemy's rear

Attacking artillery frontally is asking for trouble, as it gives the enemy gunners plenty of time for training their guns on the tanks as they approach

Correct procedure is for a few tanks to cover the artillery with long-range fire from the front while others circle to attack from the flanks and rear

that after a 900-mile desert trek 44 out of 65 Mark III's were out of service because of serious engine troubles which included frozen pistons and broken connecting rods.

These American-built tanks were early models of types which now have been greatly improved. Maj. Gen. Jacob L. Devers, chief of our Armored Force, says that they wouldn't stand a chance against the tanks now coming off our production lines.

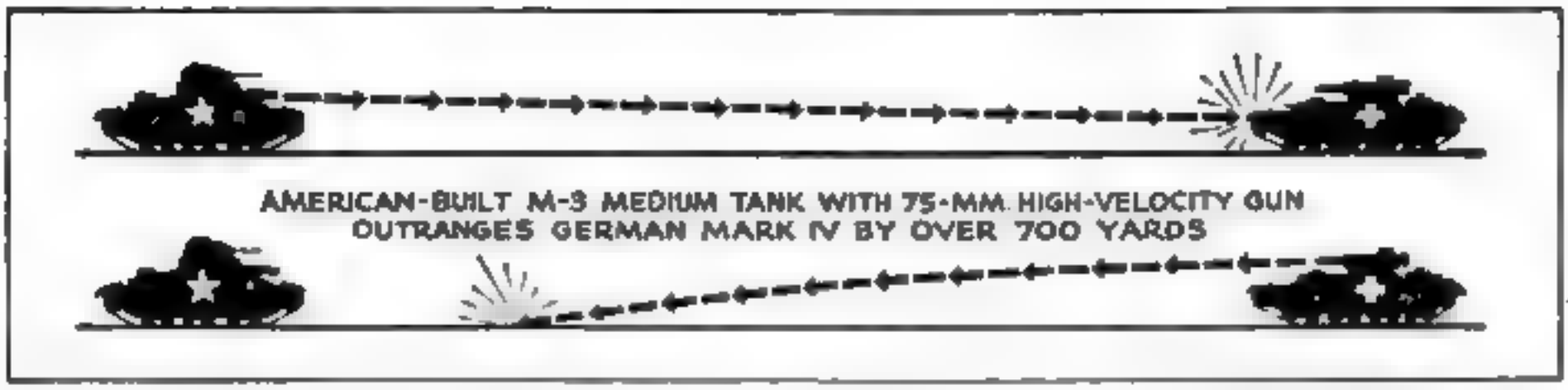
Our new tanks are the best in the world because they have been made that by over 20 years of hard work, careful planning, and patient experimenting and testing by the tank experts of the Army Ordnance Department, ably assisted by some of the outstanding engineers of the automobile industry serving on tank committees of the Society of Automotive Engineers.

When the United States entered World War I, the tank, first used by the British in 1916, had been developed into a moderately efficient and highly spectacular weapon which appealed strongly to automobile-minded Americans. In France several battalions of our newly organized Tank Corps, using equipment borrowed from the British and French, fought in our St. Mihiel and Meuse-Argonne offensives and helped the British break the Hindenburg Line. On this side of the Atlantic, Army Ordnance officers and civilian automotive engineers worked almost as hard over the difficult job of designing and building American tanks.

The first of their conceptions to get beyond the blueprint stage was the gas-electric tank built in 1918 by the Holt Tractor Company—pioneer producers of endless-tread tractors—and the General Electric Company. It was powered by a 90-hp. gasoline engine which drove a generator that supplied current to two electric motors which drove the tracks.

The next tank produced in America was a 50-tonner designed and built by the Army Engineers. It was driven at a top speed of four miles per hour by a pair of 250-hp. steam engines and its principal weapon was a flame thrower intended for attacks on concrete pillboxes—an idea which the Germans have made use of in this war. Another of the very early American tanks was the Skeleton—a daddy-longlegs tractor with a small armored body slung between its nine-feet-high and 25-feet-long tracks.

None of these experimental tanks per-



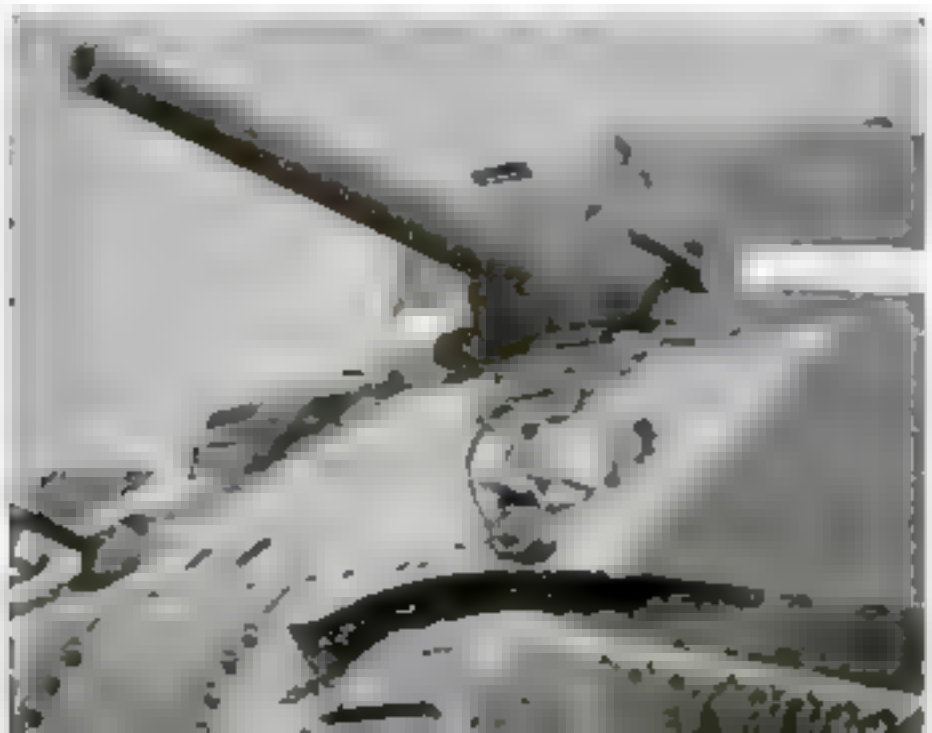
OUR TANKS HAVE BETTER GUNS IN EVERY CLASS

Our M-3 light tank, with its 37-mm. gun supplemented by machine guns, outshoots the German tanks of its class. American light tanks serving with the British were nicknamed "Honeys" by the Tommies

The 75-mm. high-velocity gun in the M-3 medium is the one that outranged the German Mark IV's as shown in the drawing above. Following its example, British mediums are being rearmed with heavier guns

In the M-4, the high-velocity gun is mounted in a 360-degree turret. As in other U. S. tanks, a stabilizer of secret design provides a steady gun platform for accurate firing while in rapid motion

Carrying a high-velocity gun of immense power, our heaviest tank (57 tons) can batter opposing mechanized units as easily as it crushed an automobile under its treads in the demonstration shown below



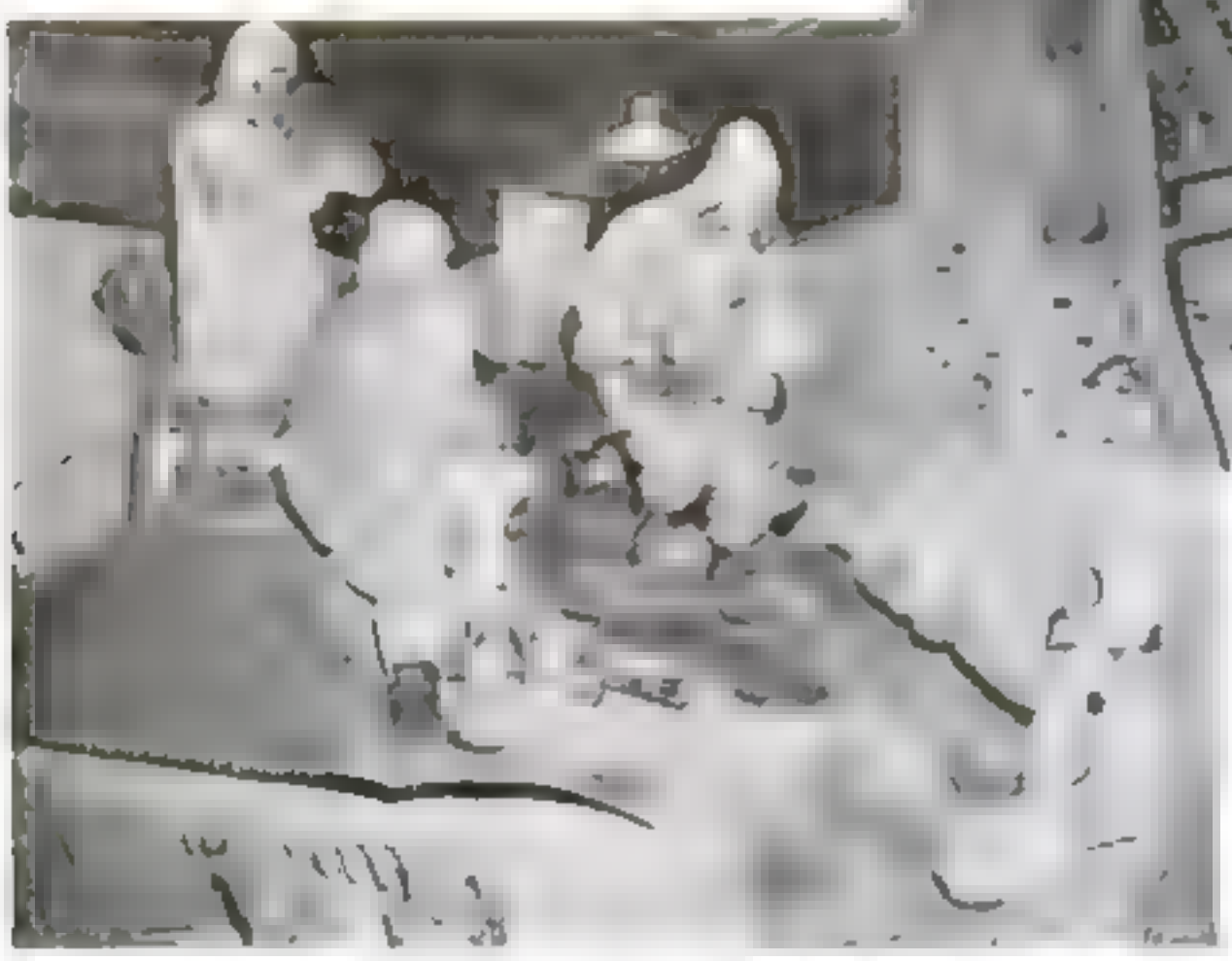
formed impressively enough to encourage the building of a second model. As tanks were needed badly, the Ordnance Department arranged with several manufacturers for the building of a copy of the French Renault, which was called the Six-Ton M 1917 Tank. Over 900 were produced in 1918 and 1919. For years they were the only usable tanks in the Army, and some National Guard companies still were equipped with them when they were ordered into Federal service in 1940. The Ordnance Department also built 100 Mark VIII 43-ton tanks of modified British design. The first one finished was tested two days after the war ended. This old Mark VIII is the tank represented on the collar insignia of the Armored Force.

Only a few of these American-built tanks were sent overseas, and none of them were used in action

The 15 years following the end of World War I were very lean ones for the Army. Far-seeing officers were urging the necessity for a degree of mechanization, but Congress wouldn t provide the money to buy the machines. Appropriations were so meager that the three Ordnance officers who deserve chief credit for the peerless American tanks of today had to cut a lot corners to go on with their experimental work. One of these officers is the Army's present Chief of Ordnance, Maj. Gen. Levin H. Campbell, Jr. The other two are Gladeon M. Barnes and John K. Christmas, both now brigadier generals and key men in our gigantic tank-production program. J. Walter Christie, former race driver, worked in close collaboration with the Ordnance men. The suspension and many other superior mechanical features of our tanks were of his invention.

Between 1920 and 1935 European armies built tanks by the thousands. We built a total of 31—but each of those experimental models was an improvement over the one which had preceded it. Engine power was increased steadily. In 1929 an air-cooled engine was used for the first time. Sliding-gear transmissions replaced the old planetaries. Speeds were increased from the five or six miles per hour of the 1918 models to over 20 miles per hour. Steering and suspension methods were improved, making tanks more maneuverable and steadier gun platforms. The toughness of tank armor was increased; in 1933 the first all-welded tank hull was produced at the Watertown Arsenal.

From those fifteen years of hard work our Army Ordnance tank specialists acquired



HOT AND COLD ROOMS at the Armored Force Medical Laboratory, Fort Knox, Ky., test men for reactions to tropical heat and arctic cold. Above, a tanker gets a seasickness test on a tilt table. At left, a tank crew discovers what 30-below-zero cold will do to a machine—and to its own efficiency

BOGIES

These are the wheel assemblies that roll inside the tracks of a tank to support its weight. Our light tanks have four bogie wheels on each side, mediums, six; heavies, eight. At right, massive bogies and hulls for M-4's meet on an assembly line in one of our big war plants

LIGHT TANK

MEDIUM TANK

60-TON TANK

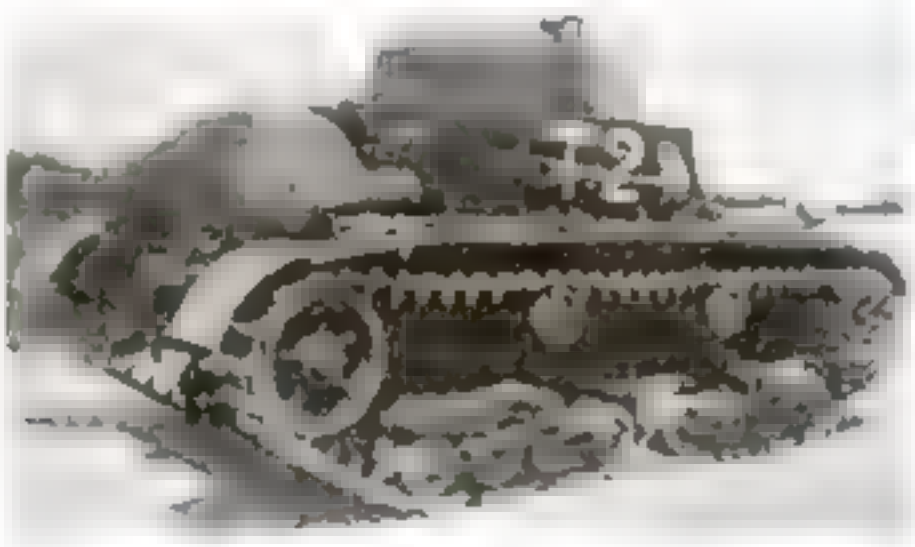
the know-how to design and build tanks that would compare favorably with those of any other army. When at last Congress heeded the urgings of Gen. Douglas MacArthur (then Chief of Staff) to the extent of appropriating funds for the building of 283 light tanks, they were ready with the design of the M2A3. It weighed 10½ tons, and its 270-h.p. air-cooled airplane-type engine gave it a road speed of well over 35 miles per hour. Its tracks, driven by front sprockets and rolling over four bogie wheels on each side which supported the weight of the body, were made of a newly developed long-wearing and heat-resisting rubber composition set in steel blocks. Infantry tanks had double turrets; the mechanized cavalry *(Continued on page 218)*

On the lookout for Axis tanks in Algeria: This is our M-5 tank destroyer, a wicked 105-mm. gun on a self-propelled mount. In addition to the big piece, it carries a smaller gun for defense against planes

EVOLUTION OF AMERICA'S MECHANIZED MIGHT . . .

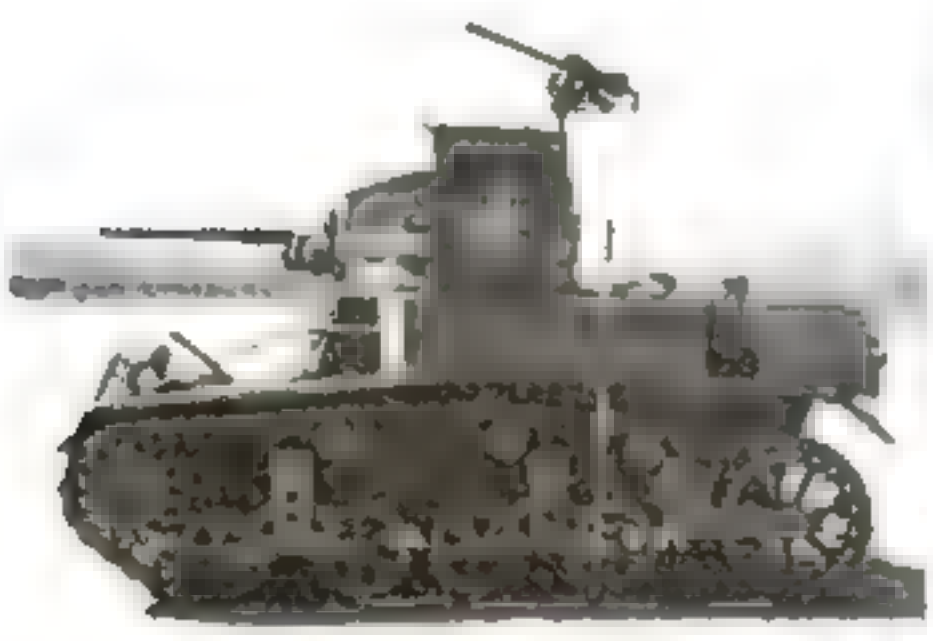
1917 First production model built in the United States was the six-ton M1917, styled after the French Renault. Over 900 were made in 1918 and 1919, and they were our Army's only usable tanks for many years

1918 First experimental U. S. design was the gas-electric built by Holt Tractor Company and General Electric. It was driven by a gasoline engine through a generator and electric motors



1929 Another experimental model of the lean between-wars years was the T1E2. It weighed 8.9 tons, and its 132-horsepower engine drove it at 16 miles an hour. Carried a 37-mm. gun, one machine gun

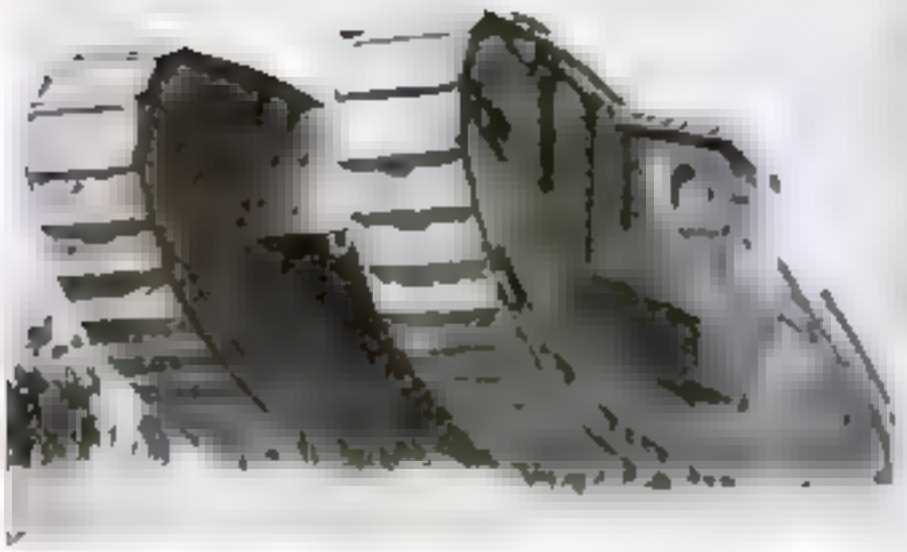
1931 J. Walter Christie, former racing driver collaborating with Ordnance experts, conceived this convertible tank and armored car. It ran either on tracks or on rubber-tired road wheels



1941 Our present M-3 light tank is a direct descendant of the M2A3, first modern fighting vehicle issued to the Army. Tanks of this type got their baptism of fire when the British hit Rommel in Egypt

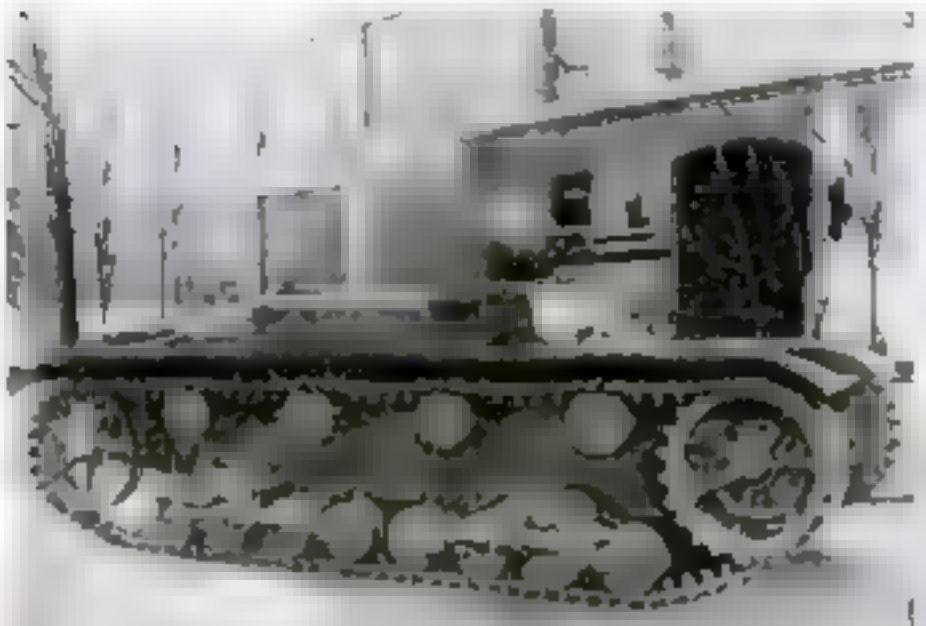
1942 The M-3 medium also won its spurs in the desert. The side-mounted heavy gun proved to be a mistake, but this has been corrected in the greatly improved M-4 medium, seen at right

OUR TANKS FROM 1917 TO TODAY—AND TOMORROW



1919 The Mark VIII 43 tonner is immortalized in the collar insignia of the Armored Force. We built 100 of these on a modified British design and most of the parts were obtained in England

1925 This 23 ton medium was an experimental job of the Ordnance Department. Powered by a six-cylinder water-cooled Packard V-8 engine with planetary and sliding-gear transmission it was fairly successful



1932 The light T1E4 used the present system of putting the engine in the rear and driving from the front. Carried a 37-mm gun, one machine gun. Powered by a V-8, 140-hp., water-cooled engine

1940 When rumblings of approaching war brought appropriations for real tank production, Ordnance experts were ready with plans for the 18-ton, 32-miles-per-hour M-2 medium, shown here on maneuvers

Putting a Stop to

AUTOS

Brake Troubles

HYDRAULIC SYSTEMS CALL FOR PERIODIC CHECK-UPS

By RALPH ROGERS

CHECKING and servicing your own automobile regularly becomes of primary importance now that more and more mechanics are being called into war work and parts are becoming harder to replace. And in your periodical check-up, do not fail to test your brakes and readjust them when necessary—their efficient operation, aside from the safety factor, will save wear on many other parts.

Most cars made since 1936 have hydraulic brakes employing a master cylinder that displaces fluid from its reservoir by a piston movement when the brake pedal is depressed. This displacement results in a pressure build-up through lines connected to similarly actuated wheel cylinders, forcing the brake shoes against the drums.

Every time brakes of this type are adjusted, and also after every 2,500 miles, the fluid level in the cylinder should be checked and, if required, replenished. Use only a fluid of approved type.

When disassembling a master cylinder, make careful note of the position of all parts so that they can be reassembled correctly. Examine the cylinder bores for rust, pits, or scoring; if they are present, the cylinder should be honed. Obtain, if possible, a hone of the proper size, and chuck it in an electric drill clamped in a vise; then slide the cylinder back and forth a few times over the revolving hone to clean up the bore, removing only the amount of material absolutely necessary. Next, check the fit of the piston in the cylinder with a feeler gauge. If the clearance is in excess of .005", put in new parts. Inspect the check valve, and should the seat be pitted or the rubber washer swollen, replace the assembly. New rubber piston cups should be installed if the old ones are swollen or distorted.

Before assembling, clean all parts thoroughly in denatured alcohol, being especially careful that the bypass port in the cylinder barrel is clear and that all sediment is removed from the cylinder.

Three types of wheel cylinders are in general use: the Lockheed, for which adjustments must be made on cams at the brake shoes, and the Bendix and Chevrolet types, which have adjustable end caps. When servicing, remove the end boots from Lockheed-type cylinders, or the end covers from Bendix or Chevrolet cylinders. The pistons, cups, and spring can then be pushed out. Clean, inspect, and recondition all types as you would a master cylinder.

Bleeding is necessary whenever a brake line has been disconnected or when a leak has allowed air to enter the system. A leak is usually indicated by a spongy brake pedal. When air, which is compressible, is trapped in the system, it prevents the full brake-pedal pressure from being transmitted to the brake shoes.

All four wheel cylinders must be bled if the main line from the master cylinder is

HOW TO DIAGNOSE THE CAUSE OF TEN COMMON BRAKE FAILURES

1 Inadequate brake-pedal reserve indicates worn lining, air or vapor in the hydraulic system, low fluid level, leakage, or a worn master-cylinder piston.

2 If all brakes drag after adjustment, check for a clogged filler vent, pedal not returning to its stop, swollen rubber due to improper fluid, or clogged piping.

3 Drag on one brake indicates insufficient shoe-to-drum clearance, weak or broken shoe-return spring, stuck wheel-cylinder pistons, piping clogged, shoes stuck, or loose wheel bearings.

4 If the car pulls to one side, look for grease or fluid on the lining, improper adjustment, piping clogged or crimped, backing plate or wheel bearings loose, wrong type of lining, primary and secondary shoes reversed, tires unevenly inflated or tread wear uneven, charred lining, brake drum scored or out of round, damp or muddy shoes, weak or loose chassis springs, or loose U-bolts or kingpin.

5 A spongy or springy brake pedal usually means air or vapor in the system.

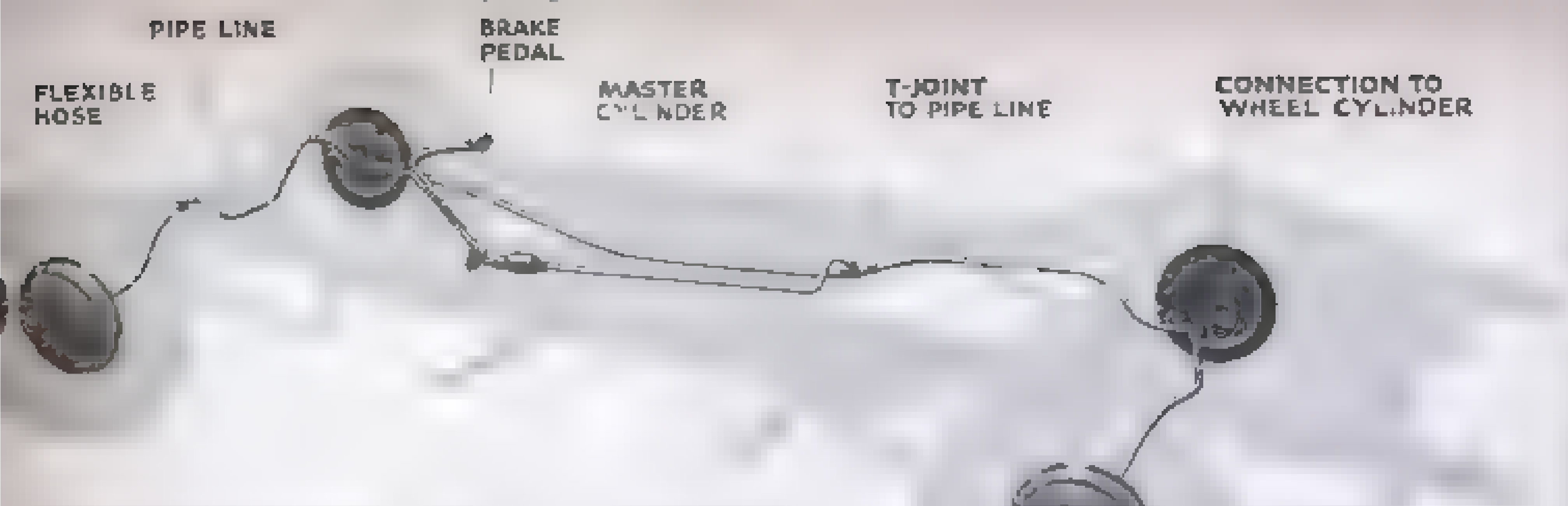
6 The need for excessive pedal pressure indicates incorrect type of lining, lining ruined by grease or fluid, or improper brake adjustment.

7 If brakes are harsh, look for a loose brake backing plate, slight amount of grease or fluid on lining, moisture, charred lining, scored brake drums, or improper lining.

8 If brakes squeak, check for twisted brake shoes, bent backing plate, metallic particles or dust embedded in lining, or loose rivets or lining.

9 Knocking brakes indicate insufficient clearance at the anchor, adjusting slot in shoe out of square, or roughly refinished drum.

10 After adjustment, if there is no pedal reserve, the pedal-stop lock ring is probably out of its seat in the master cylinder.

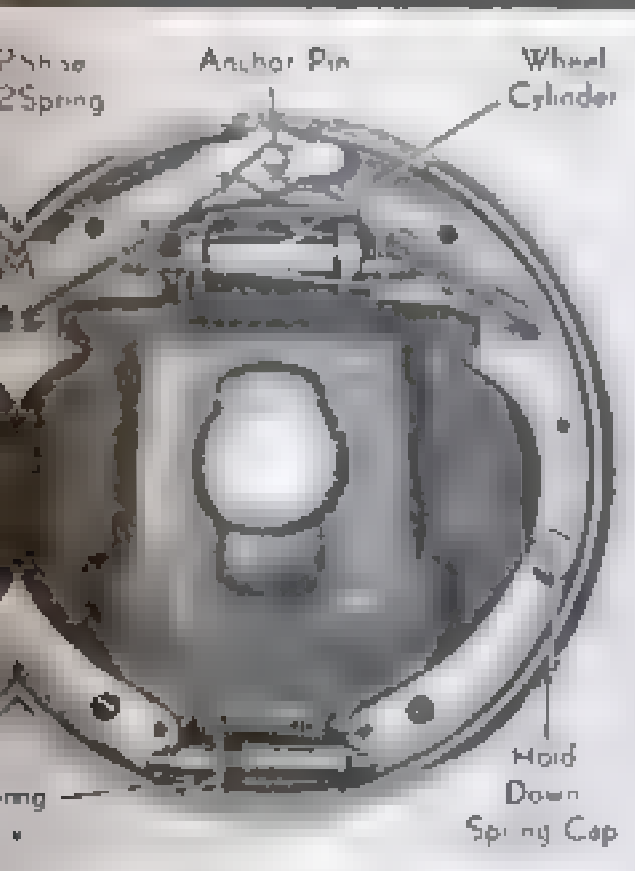


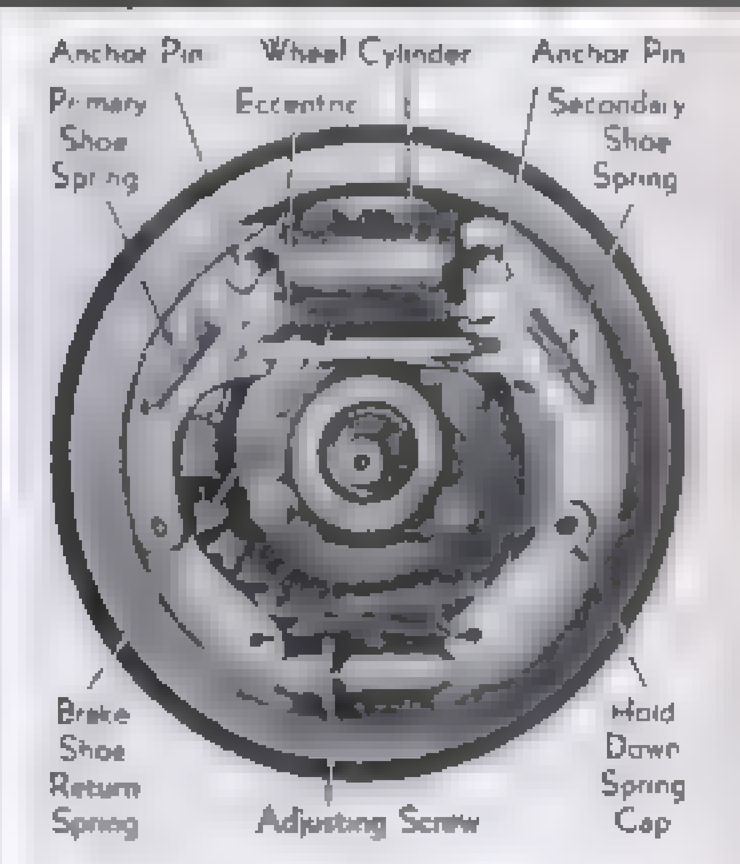
HYDRAULIC BRAKE SYSTEM. This is standard equipment on most cars of the past six years. Fluid in the master cylinder, displaced by action of the brake pedal, builds up pressure in the lines connected to the wheel cylinders, and this in turn forces the brake shoes against the brake drums

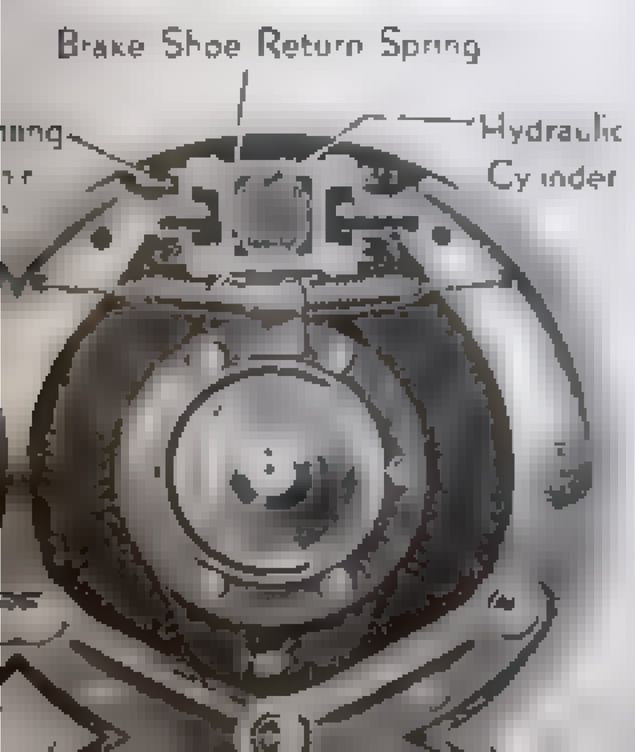
disconnected or leaks [illegible] permits air to enter, but if the line is disconnected at only one wheel cylinder, or a piston is forced out of a wheel cylinder, only that cylinder need be bled. When bleeding all lines, do the longest first. In all cases keep the master cylinder at least half full of brake fluid. *Never bleed the system or depress the brake pedal while drums are removed from the wheels.*

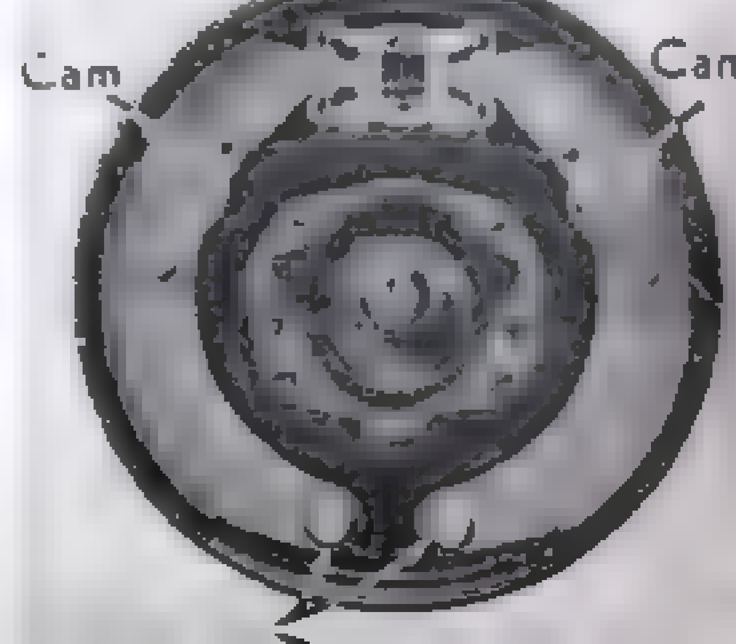
Fill the reservoir with fluid. Remove the bleeder-valve screw at the wheel cylinder and attach a drain tube, allowing it to hang in a clean jar. Loosen the bleeder valve about three quarters of a turn. Depress the brake pedal a full stroke, and allow it to re-

FOUR TYPES OF HYDRAULIC BRAKES IN GENERAL USE







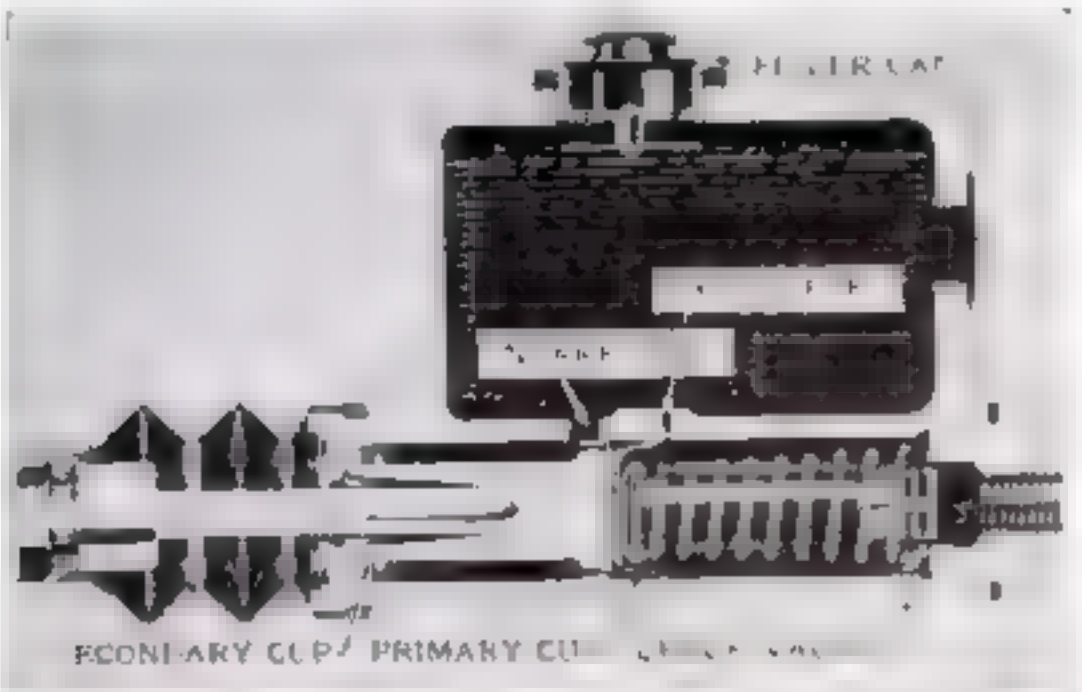


Experts urge a 2" margin of pedal reserve to counter expansion of the brake drums caused by quick stops that make drum temperature rise as high as 1,400 deg.

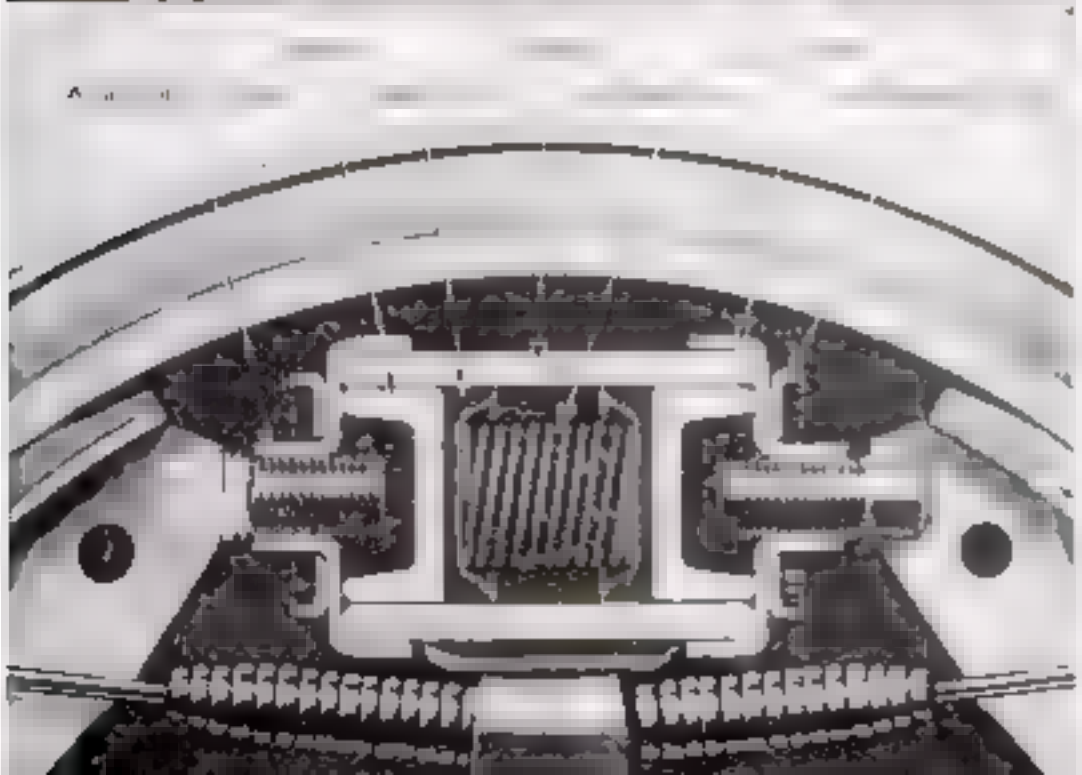
turn slowly. With the end of the tube below the level of fluid drained into the jar, continue to operate the brake pedal until the drained liquid is free from air bubbles and a solid stream flows. Then tighten the bleeder valve and remove the tube. Repeat for the other wheels. Replenish the reservoir with fresh fluid—not that withdrawn—after each wheel is bled.

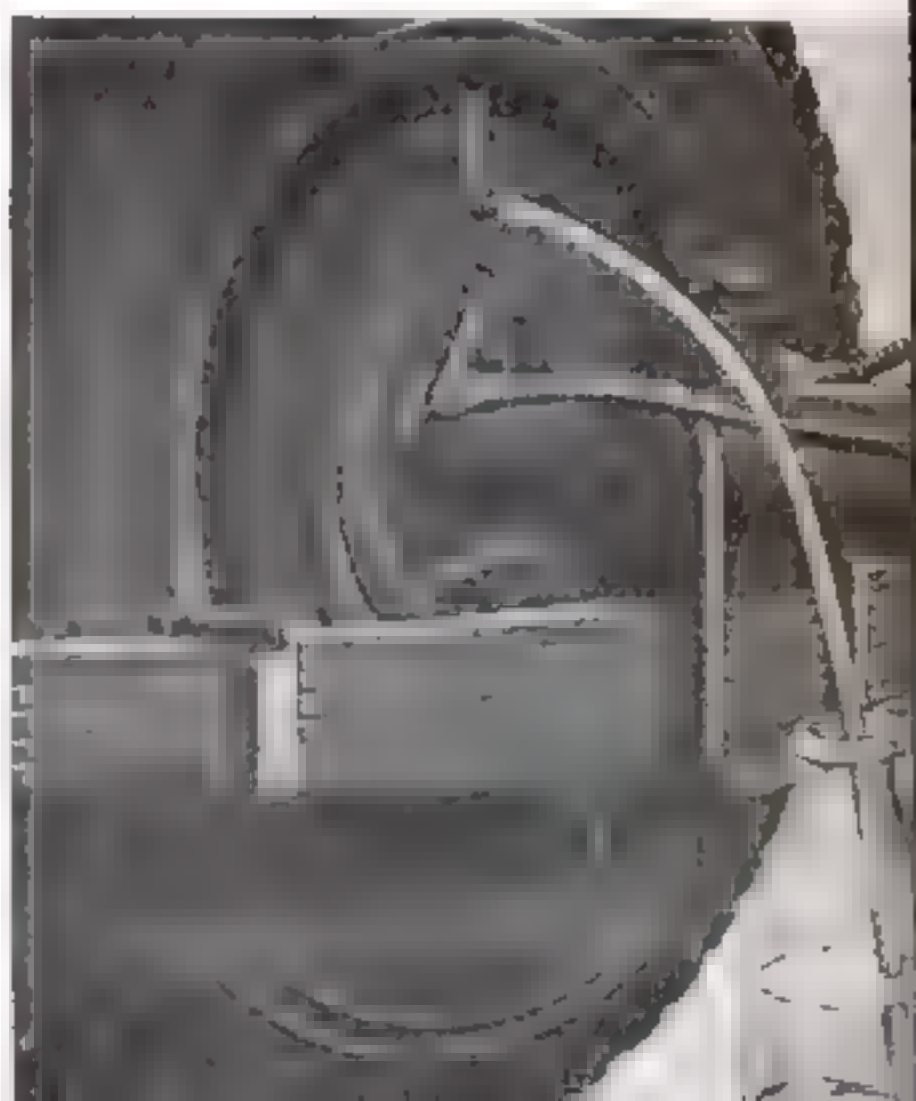
Here is a brake job that should have been done sooner. The brake-shoe lining has worn down to the rivet heads, which have scored the brake drum. The shoes must be relined and the drum either refinished or replaced

Bleeding is required if fluid in the brake system gets low and admits air. Refill the reservoir, remove the bleeder-valve screw, attach a drain tube, as below, and loosen the bleeder valve. Then depress the brake pedal, allowing it to return slowly. Repeat until no bubbles drain out with the liquid



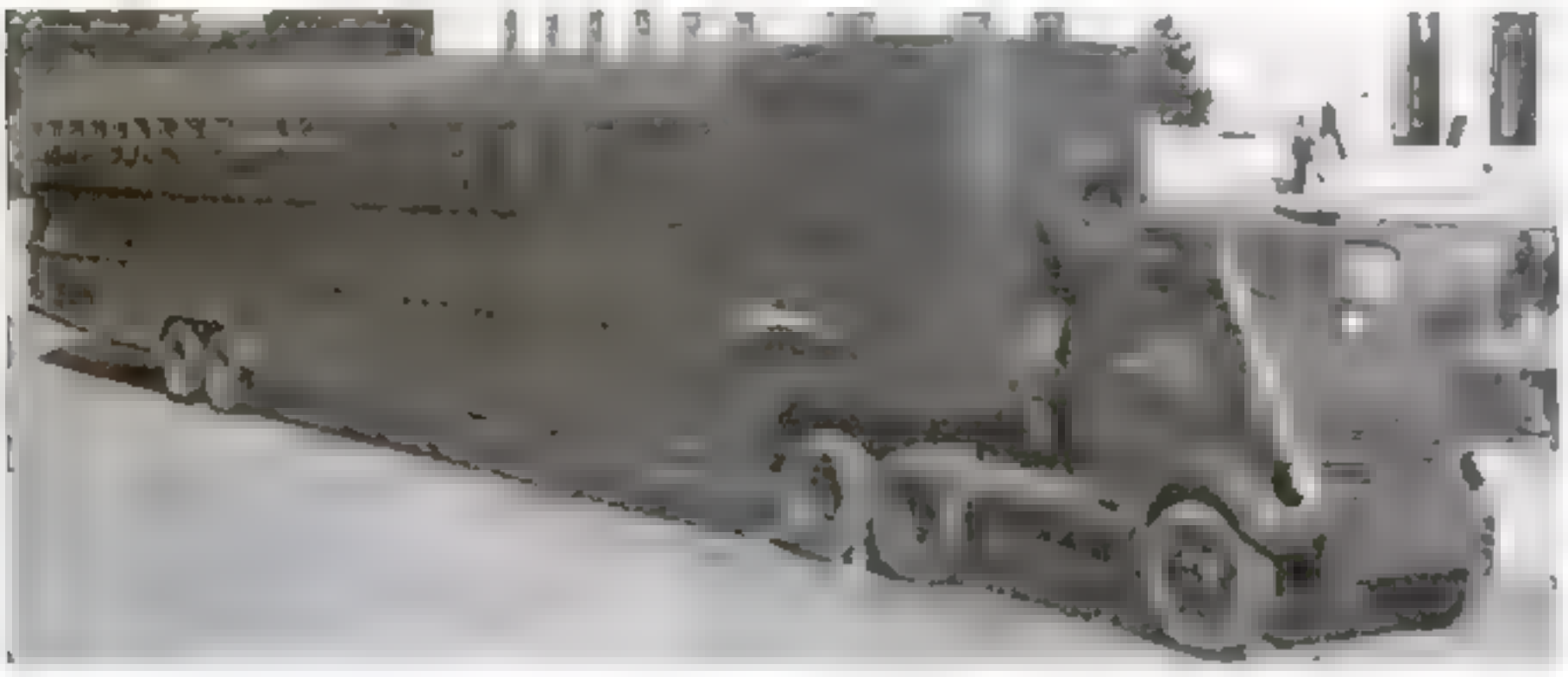
Above, broad section of the master cylinder in hydraulic brake system. When cleaning, leave no sediment inside the bypass port. Below, clean up of a Chevrolet wheel cylinder

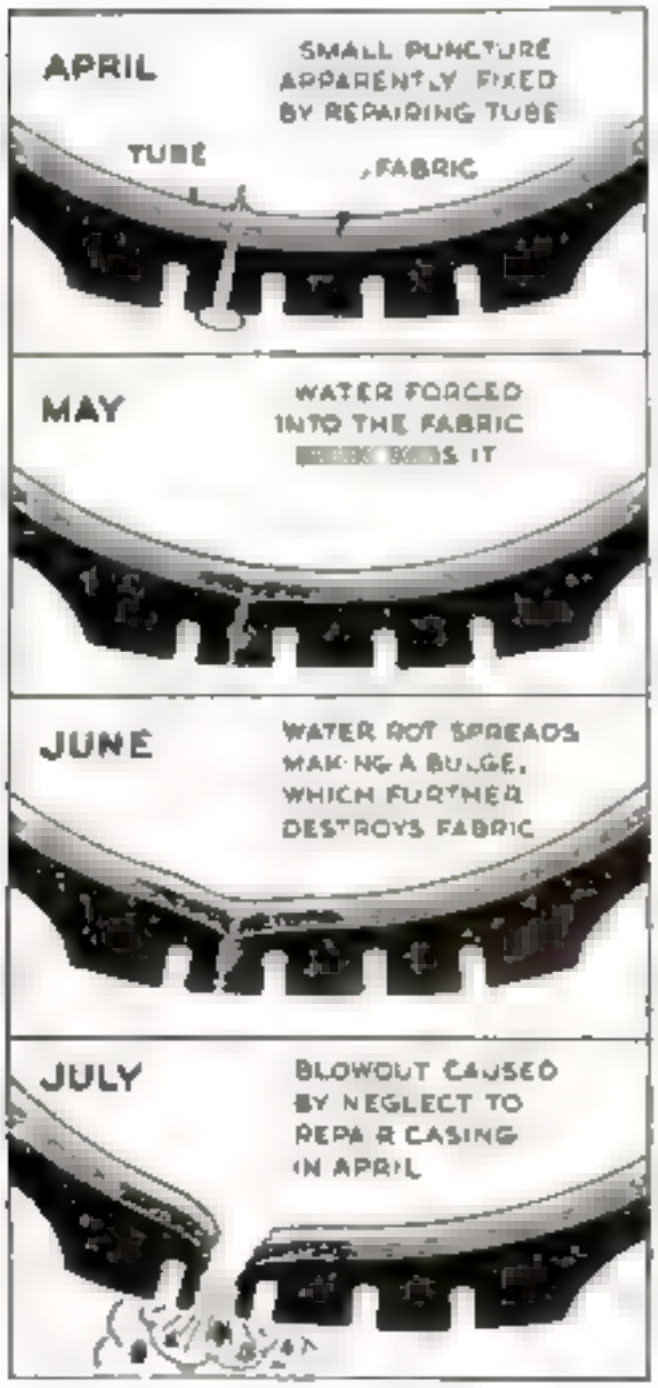




Wide Ideas

GIANT TRAILER TRUCKS 73 feet long, like the one shown below, are to haul bomber parts from factories to assembly plants 1,300 miles away. Two of these units, which were designed to relieve rail congestion, are equivalent to seven freight cars and can be loaded in less time. Each has five axles and eighteen wheels, and weighs from 50,000 to 63,000 pounds when loaded. Two high-speed motors under the cab can be pulled out on extension mounts for quick repairs, and if necessary a new engine can be installed in as little time as 15 minutes.



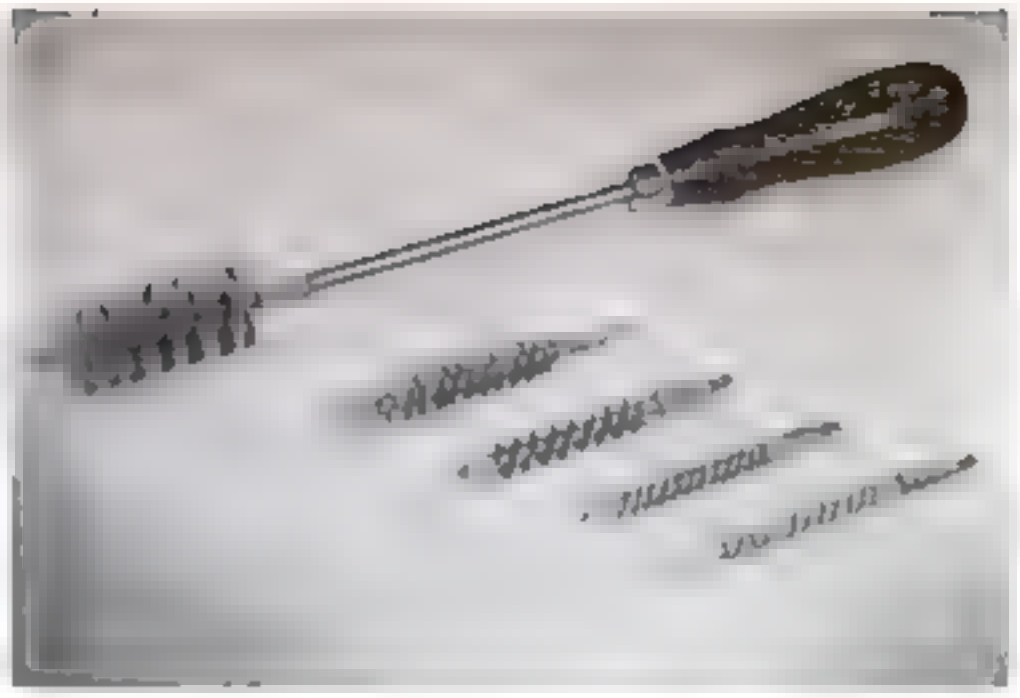


How Neglected Puncture Holes Can Destroy Your Tires

TIRES may be sabotaged from within, points out A. L. Murray, president of the Auburn Rubber Corporation. If tiny holes in the casing due to punctures are neglected, the destruction of the tire is only a matter of time.

The average car owner, Mr. Murray says, looks only at the outside of his tire and doesn't realize that while the tread is its wearing surface, its true strength really lies in the inside structure. When a puncture occurs, the driver has the tube repaired with a rubber path, overlooking the fact that the puncture in the casing must also be sealed. If this is not done, water enters the opening, eventually rots the fabric, and produces a "bulge." Soon an apparently inexplicable blowout ruins the tire beyond repair. More tires are destroyed this way than ever wear out, according to Mr. Murray

Car owners will do well to have their tires inspected inside and out, and any breaks in the casing patched or vulcanized so that water will not work into and rot the fabric. The tube should be inspected at the same time for incipient rim or bead cuts. These should preferably be vulcanized.



CARBONIZED VALVE GUIDES are quickly cleaned with a set of five interchangeable brushes, which remove hard or soft carbon without scratching the side walls. One handle takes all brush sizes, and the metal shank is sufficiently long to protect the hands from projecting studs. Brushes are evenly spiraled to give full contact with the part being cleaned, and refills may be obtained either individually or in sets.

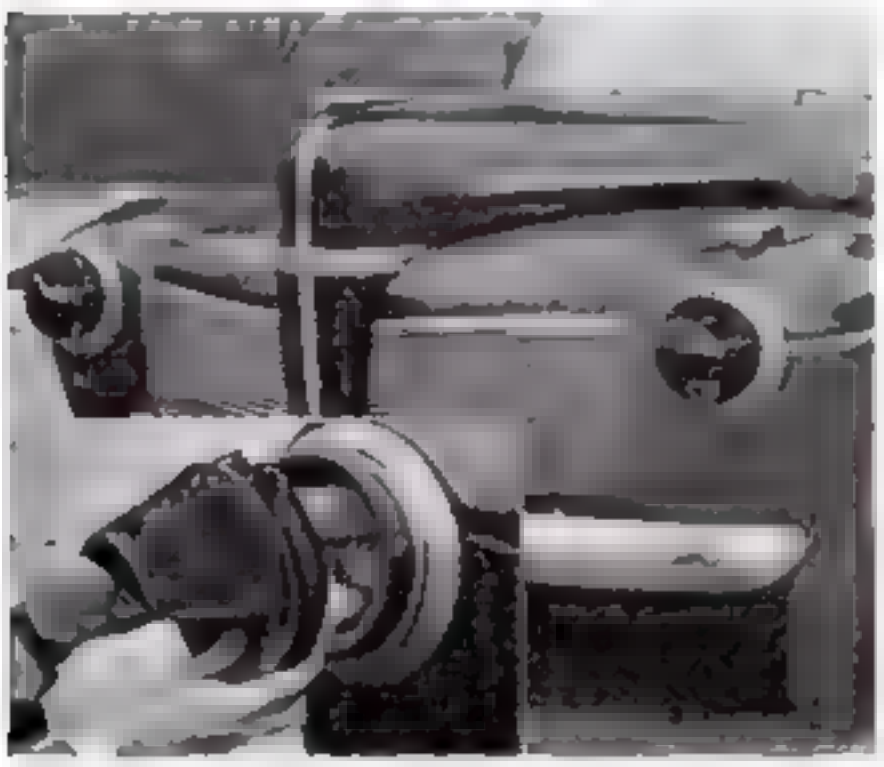
New Headlight Hoods Solve Problems of Dim-Out Driving

A SALESMAN motoring to New England a short time ago was stopped seventeen times by the local police between New York and Boston because his lights did not comply with various local wartime regulations. There were, he found, different rules in different areas, and while some enforced dim lights or none at all, others required that head lamps be as bright as usual.

To solve this problem of widely varying restrictions without having to remove or apply black paint or friction tape every few miles, an adjustable dim-out hood is now available. It consists of a fiber collar with a removable mask of simulated leather and a lightproof visor, and allows the driver to quickly shift interchangeable filters to meet local requirements, or to take the mask off entirely for normal driving.

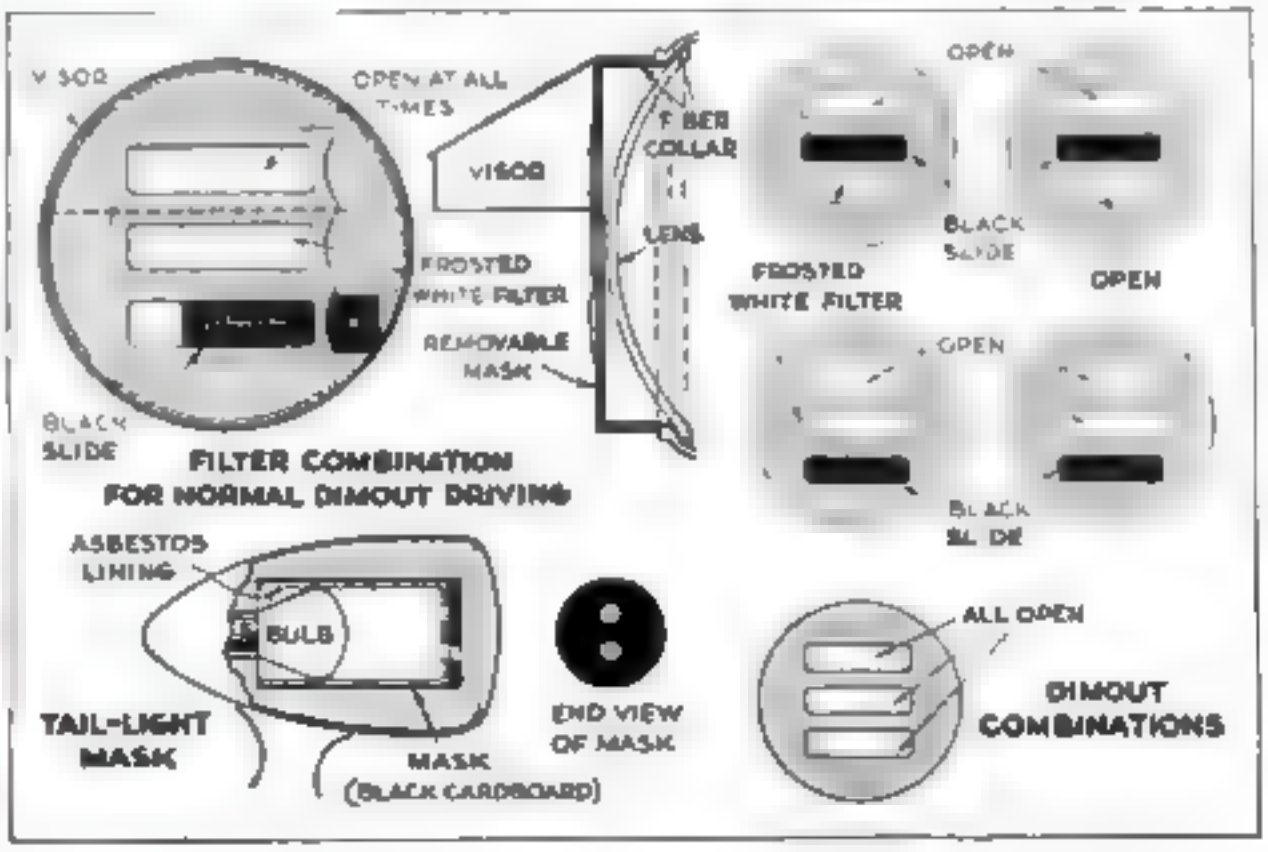
The fiber collar is firmly attached to the headlight. This need not be removed at any time, but may remain on for the duration. The mask is then fitted to the collar—not to the lamp itself—and opaque black or frosted white filters are inserted in the openings in various combinations, some of which are shown below. However, the top slot is left open at all times, as its light cannot be seen from above because of the visor.

A tail-light mask also may be obtained in two sizes to fit different makes of cars. It is made of asbestos-lined cardboard, and slips over the bulb as shown in the drawings. The light is visible through two holes in the end cap.—ARTHUR MILLER.

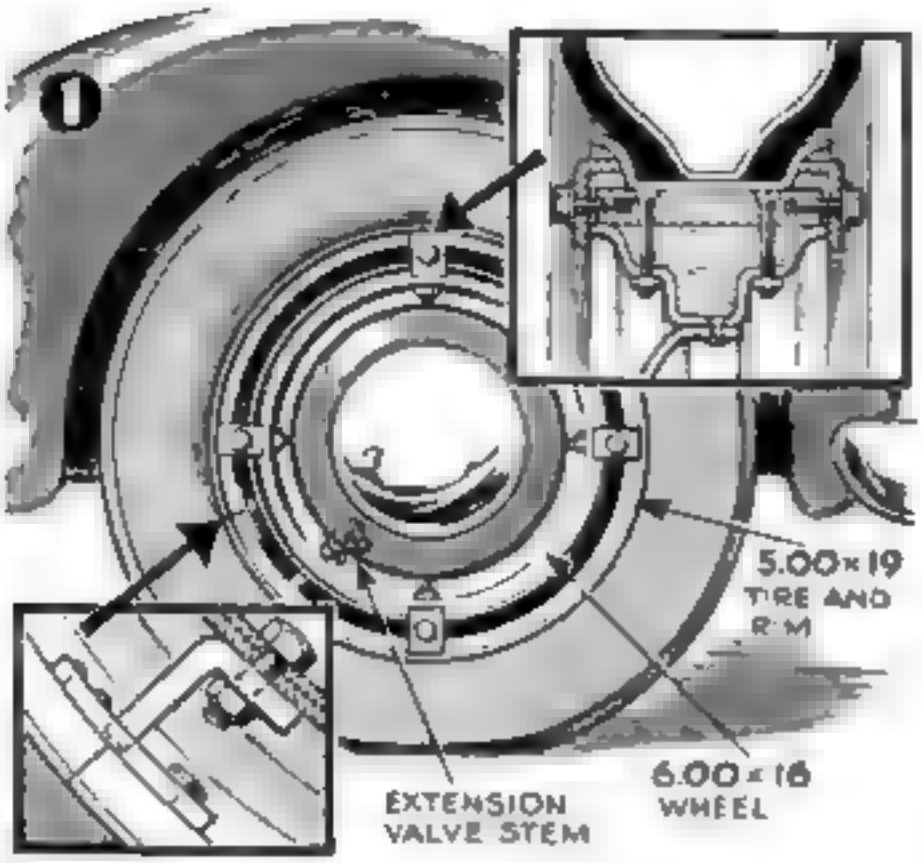


Car equipped with hoods for dim-out driving. Inset shows the mask being placed over the fiber collar

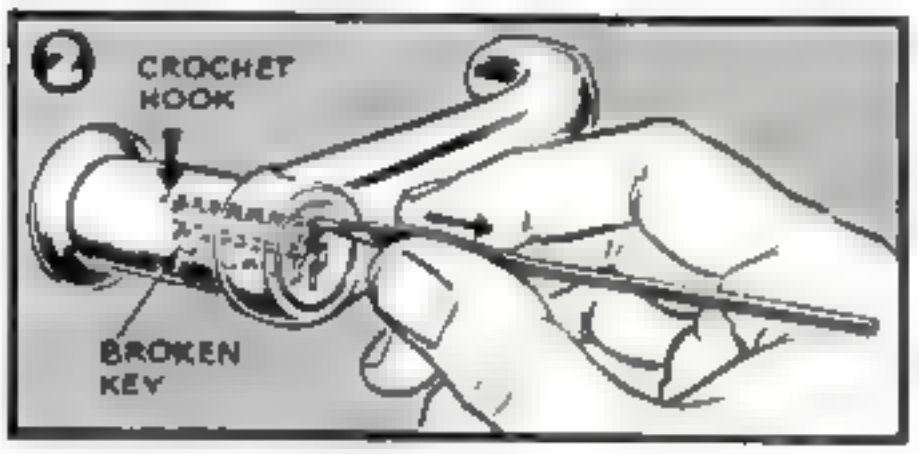
Two ways in which headlights can be changed to suit rules



USEFUL AUTO HINTS



1 OLD-STYLE TIRES of large rim diameter can be made to serve on small wheels by the use of the adapter shown in the drawing. Here a 5.00-by-19 tire and rim are mounted on the rim of a 6.00-by-16 wheel, but with slight changes the method can be applied to other sizes. Bar stock, ⅝ by 1 inch, and as long as the rim is wide, is bolted with countersunk bolts to the small rim through hardwood filler blocks, as in the upper right inset. Drill and tap the ends for bolts holding angle-iron lugs. Channel-shaped shims may be needed to center the large rim on the bars and eliminate looseness. An angle lug (lower left inset) engages the existing lug on the small rim. A right-angle extension valve completes the setup.—A. A. L.

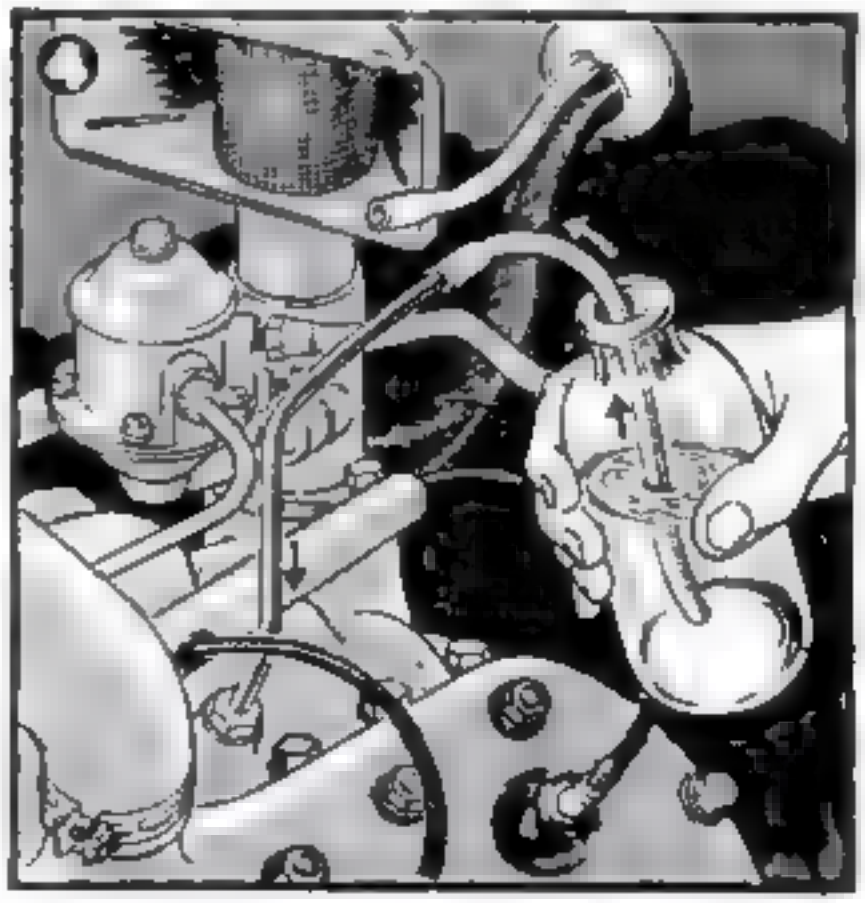


2 BROKEN-OFF KEYS are easily removed from car-door or other locks with the help of a fine crochet needle. Push the needle in above the key until the hook is past the end, and pull out carefully.—A. H. W.

3 BOTTLE-FEEDING A MOTOR may save a tow if the feed pump fails. Puncture the cap of a bottle and feed gasoline through it directly into the carburetor.—J. R.

4 ZERO-WEATHER PRIMING can be done when necessary through the windshield-wiper vacuum line. Pull the hose off near where it enters the intake manifold, attach another hose and insert it in a bottle of gasoline. Turn the engine over a few times, remove bottle, and start as usual.—H. D. DE W.

Drawings by STEWART ROUSE



"New parts are hard to get," Gus said. "That's why I keep telling my customers to take care of their cars."

One on the House

Gus Foots the Bill as a New Mechanic Bungles a Job

By MARTIN BUNN

IT WAS a fine sunny morning, and Gus Wilson should have been whistling as he went about his work in the Model Garage shop. But he wasn't.

George Knowles noticed this the moment he came in. "What's biting you this grand and glorious morning?" he wanted to know. "First time I've ever seen you looking as though the world was too much for you."

Gus looked at him glumly; then his face broke into a crooked grin. "I guess I'll have to admit I'm not up to par," he confessed. "Trying to run an auto repair shop these days is a headache."

"Headache!" George said feelingly. "You ought to try running my business in wartime! But what's your particular trouble?"

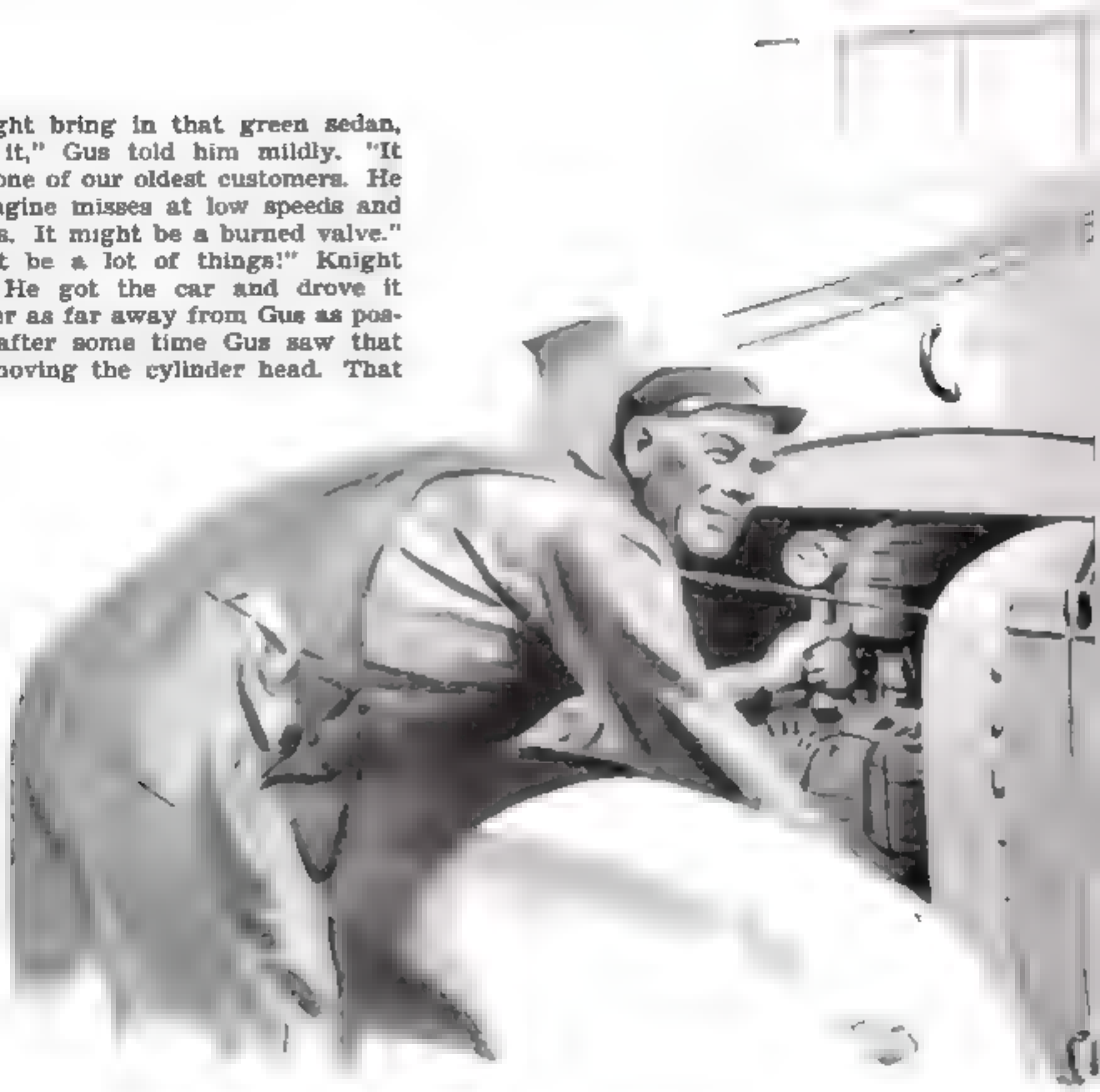
"Getting spare parts and materials, for one thing," Gus told him. "But my toughest problem is finding a mechanic who won't do more harm than good. Wally, the grease monkey we've had for the last year or so, was drafted last week. I'm not kicking about that—the Army needs men—but it did leave us in a hole. Joe Clark put an ad in a city paper, and snapped up the only fellow who answered. But the man wants to do everything his own way. Well, that's enough about *my* troubles, George. How about yours?"

"The one on my mind right now," Knowles said, "is my car. It runs well enough at thirty on the level, but it misses badly when I tramp on the accelerator to pick up at lower speeds and whenever I go up a hill. I know you're busy, Gus, but I'd appreciate it if you could get it fixed up by late afternoon. I've got to drive to an air-raid wardens' powwow." A horn honked outside. "There's Peggy. See you later, Gus."

Knowles went out. Gus kept on working on a job he'd promised for noon. Presently Henry Knight, the new mechanic, came in from the office, where he had been arguing with Joe Clark. "Well, what do you want me to tackle next?" he growled at Gus.

"You might bring in that green sedan, and check it," Gus told him mildly. "It belongs to one of our oldest customers. He says the engine misses at low speeds and on upgrades. It might be a burned valve."

"It might be a lot of things!" Knight grumbled. He got the car and drove it into a corner as far away from Gus as possible, and after some time Gus saw that he was removing the cylinder head. That



Gus pressed the starter again, watching the tester dial. "It's blowing past the rings," he said. "If it were a valve, this reading would be same as the first."

done, Knight drained the crankcase. Gus had told him to check the car, not to do a job on it, but he said nothing. Knight then went into the storeroom back of the office, and came out with a new cylinder-head gasket.

Gus finished his own job, then drove out for a road test. When he got back the Knowles car was standing outside. Knight was in the shop writing out a material slip.

"I finished that job," he growled. "There was nothing the matter with the valves."

"No?" Gus said. "Well, I guessed wrong."

"When I took the head off to check the valves," Knight continued, "I saw some drops of water in No. 3 cylinder. So I drained the crankcase, and a lot of foamy oil and some water came out. The block wasn't cracked, nor was the cylinder head, so it had to be the gasket—I'd noticed it looked bad. I put in a new gasket, and filled her up with oil. Here are the slips on the job, filled out the way you want 'em."

"O. K.," Gus said. "Take them in to Joe."

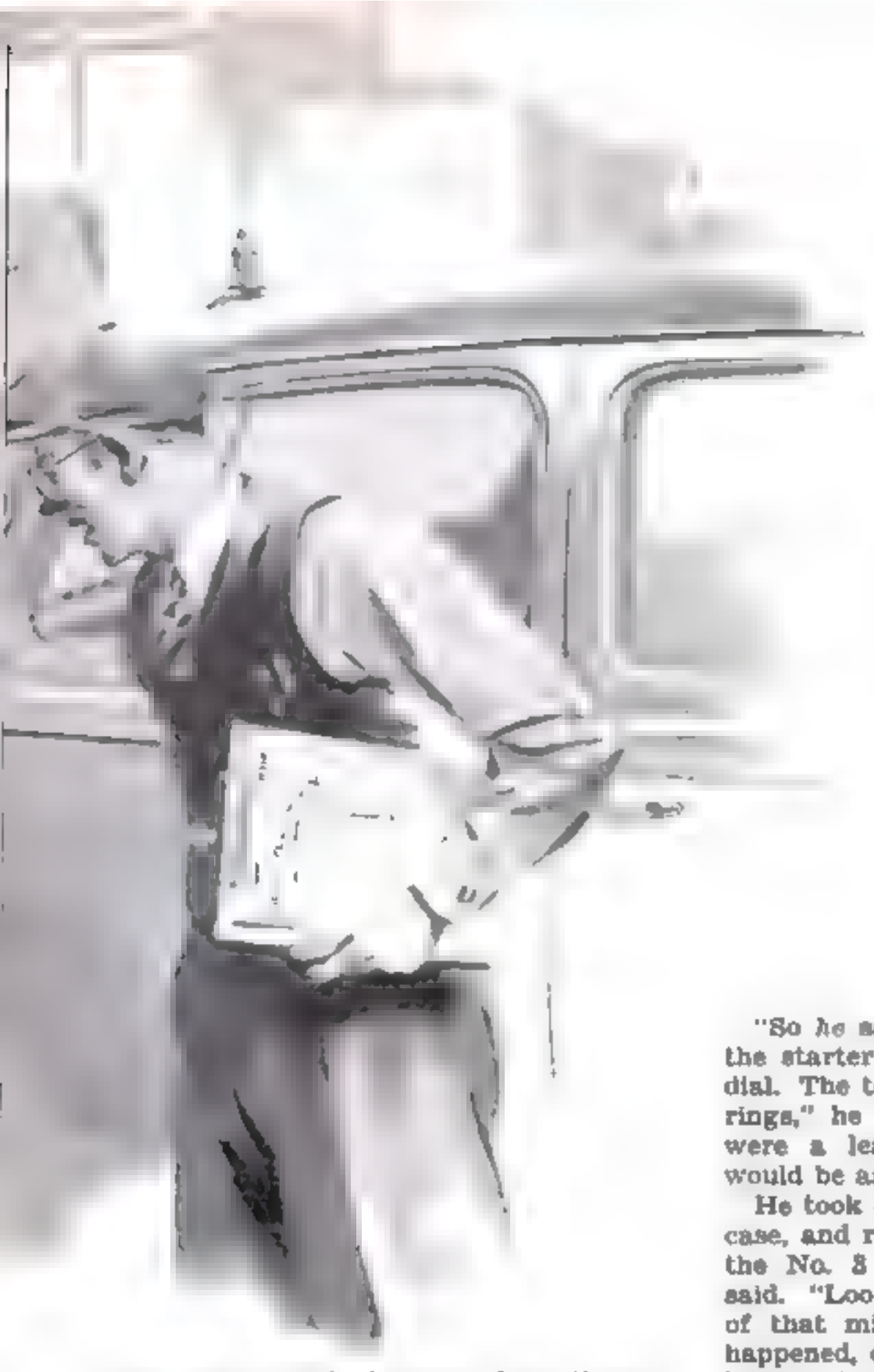
All the rest of the day Knight went on doing things in his own way. Gus made no suggestions, but he was glad when, at five o'clock sharp, the new mechanic put on his coat and went home. When George Knowles came in a half hour later he found Gus whistling cheerily.

"Got over your grouch, hey?" Knowles grinned. "That new man must have turned out better than you expected."

"I *think* he's a good mechanic, but I *know* he's a pain in the neck," Gus said. "He worked on your car—put in a new gasket, and filled the crankcase with fresh oil. You shouldn't have any more trouble."

Knowles went out to his car. Gus heard the engine start, and knew from its sound almost at once that it was missing. He hurried to the door, but Knowles was already in the street and didn't hear his shout above the noise of the motor.

Gus watched him drive off, shrugged, and



went inside. He had supper late, then returned to finish a job. It was close to midnight when he decided to quit.

Just as he was washing up, the telephone rang. George Knowles' voice came over the wire. "I'm in trouble over at the county courthouse. My motor missed all the way here and now it sounds as if it might shake itself apart. I'm afraid to start home —I don't want to get stuck. All the garages here are closed."

"Stay right where you are," Gus told him. "I'll be there in half an hour."

When he got to the county seat, he found Knowles apologetic for having brought him out so late. "Forget it, George," Gus said. "You ought to be cussing me, not apologizing. I should have checked your bus myself. Need it early tomorrow?"

"No, but I'd like to have it by six."

"I'll get at it first thing," Gus promised.

He got down to the shop an hour early, and tackled Knowles' car. When he stepped on the starter the engine took off promptly. After letting it warm up, he switched off the ignition, took out all the spark plugs, poured a spoonful of penetrating oil into each cylinder, and turned the engine over with the starter to distribute it. Then he got out the compression tester, pressed its rubber adapter into the No. 1 spark-plug hole, opened the throttle all the way, and punched the starter button. The hand moved up to the 100-pound mark. Cylinder No. 2 registered 102 pounds. But on No. 3 the reading was only a little over 50. The remaining cylinders tested 100 or more.

As Gus was pouring in a little heavy oil on top of the No. 3 piston, being careful not to get any on the valves, Joe Clark came in. "What's the matter?" he asked on seeing Knowles' car. "Knight took care of that job yesterday, didn't he?"

"So *he* said!" Gus answered. He pressed the starter button again, and watched the dial. The tester showed 80 pounds. "Leaky rings," he said. "The oil seals 'em. If it were a leaky valve, the second reading would be as low as the first."

He took off the head, dropped the crankcase, and removed the piston and rod from the No. 3 cylinder. "I'll be darned!" he said. "Look at this, Joe. About an inch of that middle ring broke off, and as it happened, didn't damage the cylinder wall, but stuck fast in its groove directly under the gap of the top ring. The result was a blow-by that killed compression and caused missing. Well, George will have to pay for a ring job. By gum, Knight was right about the cause of the trouble at that—a hundred to one it was water leaking past that bad gasket that made the ring break."

Joe looked at the shop clock. "Where the dickens is Knight?" he asked. "He's half an hour late. There's the phone."

He went into the office. A minute later he came back. "Bad news, Gus," he told his partner. "Knight has quit. He phoned to say he's taken a job in the city."

"I'll say it's bad news," Gus growled. "I wanted to fire him! He knew he hadn't fixed Knowles' engine, but just wouldn't admit it. When you make out George's bill, leave off what Knight did. That'll have to be on the house."

"Profit and loss," Joe said. "Mostly loss."

"Yes," Gus agreed. "Like Henry Knight!"

PROJECTING *Your* Black-and-Whites

SLIDES MADE FROM ORDINARY NEGATIVES
PRODUCE BRILLIANT IMAGES ON THE SCREEN

By WALTER E. BURTON

FOR a new thrill in photography, try making black-and-white slides for projection, instead of prints on paper. An ordinary print is seen by reflected light, but the maximum beauty of a photograph is best brought out by transmitted light. Transmitted light pictures, or transparencies, are capable of showing a fuller range of tones, and possess greater brilliancy. Of course, the most effective way of viewing such transparencies is by projecting them on a screen.

Lantern slides, besides squeezing the last bit of beauty from an ordinary snapshot, have other advantages. Making them can be a fascinating hobby in itself. Schools have found them an effective teaching medium, and they are being widely used for instructing civilian-defense workers, emergency police, and air-raid and fire wardens.

There are two popular lantern-slide sizes. The older, 3¼" by 4" measured along the outside edges, is used mainly in large auditoriums. The newer 2" by 2" slide is popular because of its convenience and low cost. It, too, can be projected for large audiences.

Photographic manufacturers offer a variety of supplies for making black-and-white slides. The most popular sensitized materials are listed in a table on page 148. All film used for projection transparencies should be of the safety-base type, to reduce fire hazards. In addition to films or plates, the following auxiliary supplies are generally used:

Cover glasses are clear, flawless sheets of glass to protect the photographic image. One cover glass is required for each plate, or two for each film transparency.

Binding tape may be cellulose film, gummed paper, or cloth. It is used to bind and seal the edges of the plate and cover glass, or of the two glasses used to cover a film transparency

Locating dots—small disks of gummed paper—are useful for indicating the position of the slide in the projector, and for numbering or coding.

Masks cut from paper are bound with slides to form opaque frames around the picture areas. Sometimes the binding tape serves as a mask.

Varnish or lacquer, applied over the emulsion, prolongs the life of the slide by retarding fading or other deterioration. It is especially advisable in damp climates.

It makes little difference whether you use film or glass plates, so long as you produce a good image. There are several methods of printing positive transparencies. Often the process is complicated by the fact that the image must be smaller than the original negative, which must therefore be reduced. If the slide image may be the same size, it is simply a matter of contact printing

To make a lantern slide by this method, you clamp the plate or film against the negative and expose as you would when printing on paper. A conventional printing box or frame may be used. The speed of the emulsion on lantern-slide plates and films varies considerably, but in general it is greater than that of paper. So you will need a less intense light (10 watts). If the printing-box platen seems to produce too much pressure on a glass lantern-slide plate, you can use a weight instead to hold the plate against the negative. A layer of felt, cloth, or blotting paper will prevent

Printing a lantern-slide plate by contact. The platen of the printing box seemed to exert too much pressure, so a padded weight was substituted

This easily made holder may be used instead of a printing box. One frame of a 35-mm. negative is in position. At left is a lantern-slide plate

In projection printing, the lantern-slide plate rests against a steel square. Lay a mask on the plate while focusing, but remove it for exposure. A safety filter or focusing plate will be needed

Masks may be cut with the help of a variety of tools and templates. Here a 1½" wood chisel is being used along with a simple cutting guide. The wide sides of the masks are trimmed off later

SENSITIZED MATERIALS FOR SLIDE MAKING

Material	Contrast	Uses
Positive film	Normal	Slides from average negatives
Positive film	High	Copies of printed matter, drawings, and so forth
Direct-positive film	Normal	Direct positives of any subject without use of negatives, copies of other transparencies and prints
Process film	High	Slides of printed matter, drawings, and the like
Negative film, preferably slow-speed	Normal	May be used when positive films are not available
2" by 2" glass lantern-slide plates	Soft	For printing negatives of extreme contrast
2" by 2" plates	Medium	Prints from average negatives
2" by 2" plates	High (antihalation)	Printed matter, line drawings, and prints from soft negatives
2" by 2" plates	High (special)	Fine detail and freedom from abrasion marks in reproductions of drawings
3¼" by 4" plates	Same as 2" by 2"	Same as 2" by 2"

Note: All film used for projection transparencies should be the safety-base type, to reduce fire hazard.

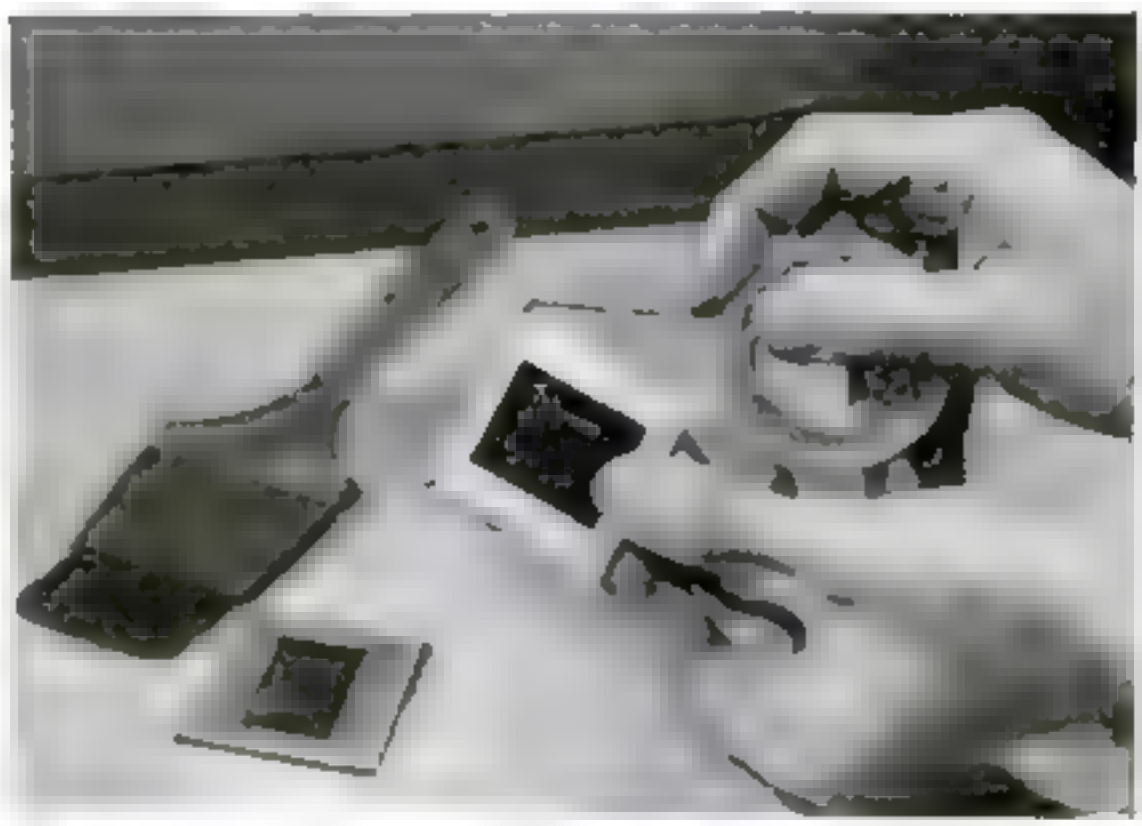
scratching or other damage to the glass.

Determining exposure is an art that develops with experience. Instructions available for some makes of lantern-slide plates contain suggestions for using enlarging paper for test exposures. Otherwise the test-strip method is generally used. That is, a plate is entirely masked except for a strip ¼" wide, and an exposure of 5 seconds is given; then another ¼" is uncovered and another 5 seconds given; and so on for the rest of the slide. One strip will show an exposure that is correct or nearly so.

Projection printing in which the slide image is bigger than that of the negative is essentially the same as enlarging on paper. Use a blank, undeveloped lantern-slide plate to focus on. Place it emulsion side up against an L-shaped piece of wood or metal resting on the easel. Put over the focusing plate a mask of the same size and shape that you intend to bind with the transparency, and focus the image in its opening. Then remove both the mask and the focusing plate, substitute an unexposed plate, and make the exposure.

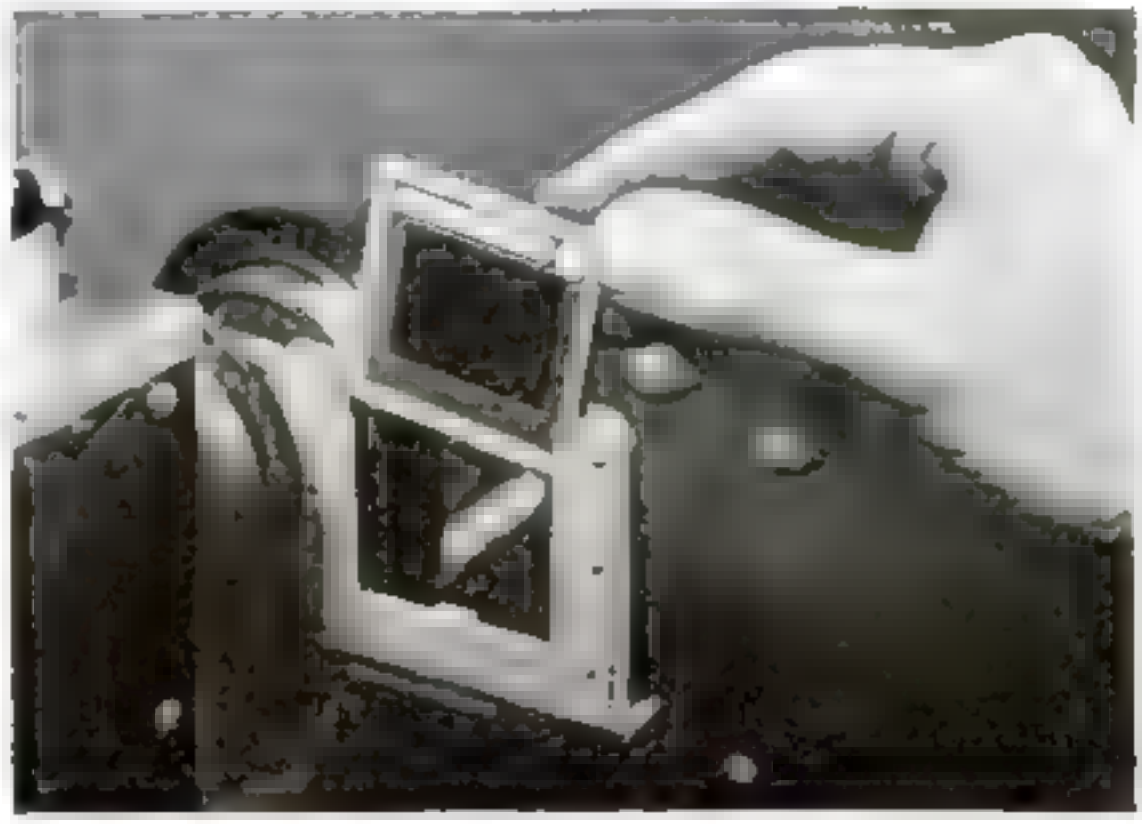
To form a projected image the same size as the negative, the enlarger lens has to be moved twice its focal length from the negative; to produce a smaller image, it has to be moved even farther. You may substitute a lens of shorter focal length, use an auxiliary copy attachment or other positive

Tape, signal dots, penknife, mask cut from metallic paper, and cover glass are needed in binding the transparency shown with them above



(magnifying) lens over the regular enlarger objective to shorten the focal length, or mount the lens on an extension tube such as an empty tin can or a boxlike frame made of thin wood, or heavy cardboard, and painted dead black inside. Focus for maximum sharpness, using a magnifying glass if possible.

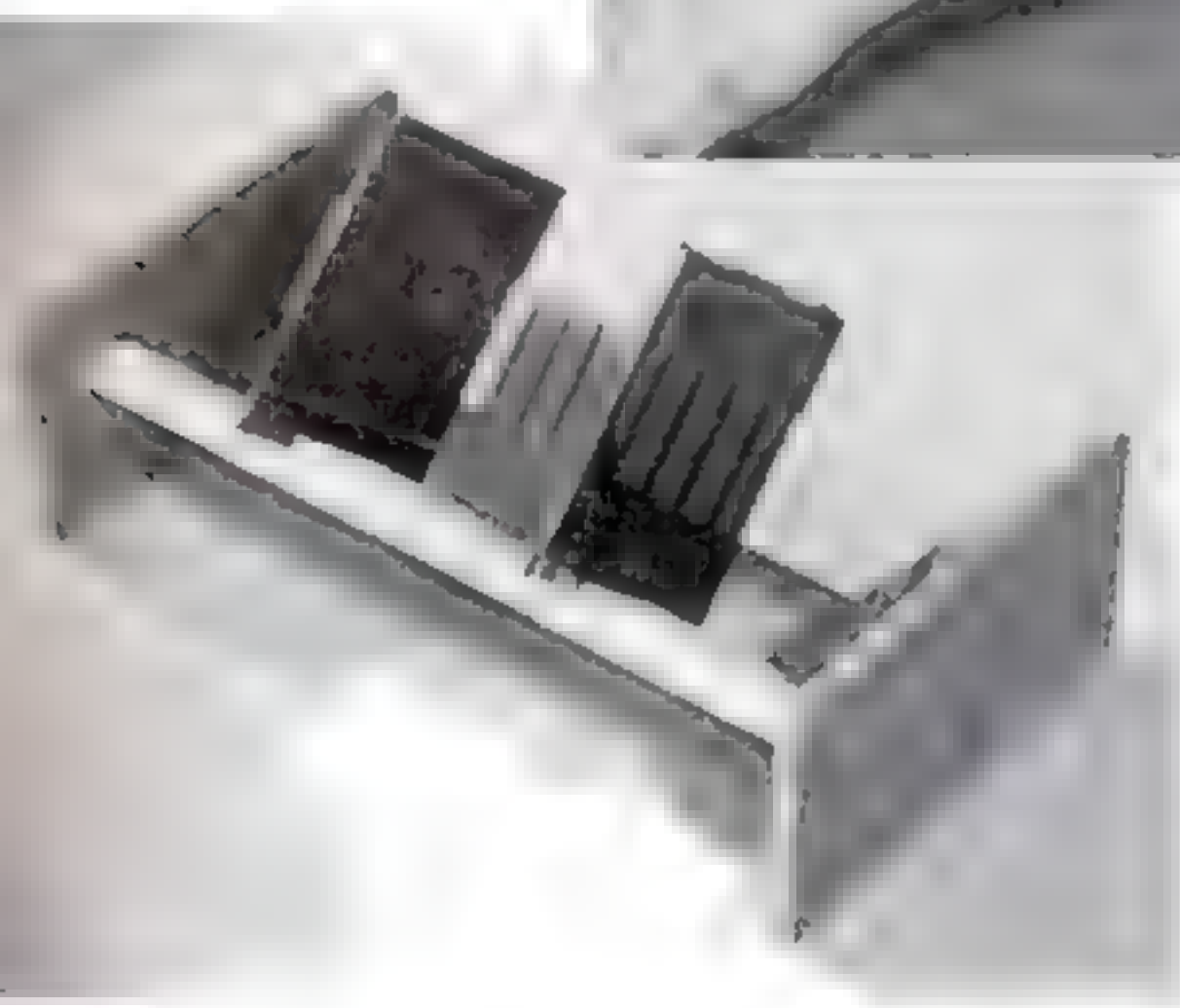
A third method of printing is to place the unexposed lantern-slide plate or film in a camera and photograph the negative, illuminated from behind. Typewritten sheets, book pages, line drawings, and similar subjects may be copied directly. The resulting negative image is suitable for projection. When direct-positive film is used, a positive image is obtained without



Taping is started at the bottom of the slide, as at right above, so the joint will be at the top when the slide is inserted in the projector. At the lower right, the lettering is in position for reading when the slide is filed

If white enameled trays are used in developing slides, the images will stand out, and may be viewed as work is done

Transparencies can be dried best in dust-free atmosphere. Stand them in a rack similar to the one below, which was made from small bits of scrap



the use of a negative. The camera method is also used for copying other slides and making positives from negatives. In either case the original should be held in a frame and illuminated from behind by light diffused evenly through an opal-glass or similar screen.

Safety film may be cut into pieces of the required size, such as 1 15/16" by 1 15/16" (the dimensions of a 2" by 2" slide before binding with tape), and printed in the same way as glass plates. One method of printing 35-mm. film strips by projection is to load the film in a miniature camera from which the lens has been removed, and lay the camera on the enlarger easel in such a way that the image can be focused on the film. Focusing may be done through a red or orange filter.

The manufacturer's recommendations for developing should be followed. Expose so that, on full development—usually 1 to 3½ minutes—the picture on the slide will be brilliant. The deepest shadows should be slightly transparent. The whitest high lights should show a slight veiling. If the whole slide, including unexposed edges, shows a general veiling, it has been fogged either by chemical action in the developer or by stray actinic light. A treatment with a reducer such as Farmer's well-known formula will generally clear it up.

After development, fix the plate or film in fresh hypo solution containing a hardener, and then wash it in running water for about 45 minutes.

If projection reveals pinholes, retouch with water colors or other spotting pigments.

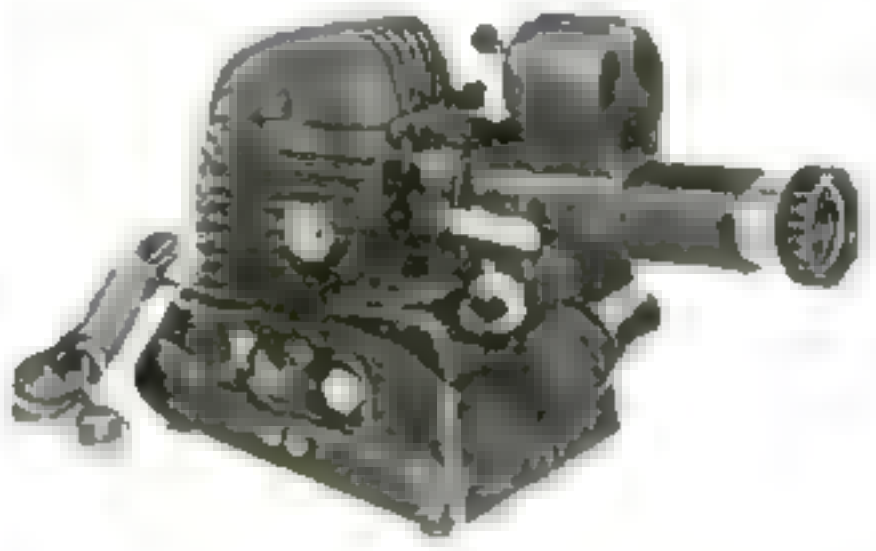
Standard masks may be purchased for 2" by 2" slides. If you cut your own, one side may be black, but have a white or metallic surface face toward the projector to reflect heat. You can make satisfactory masking paper by running an inked roller over one surface of white paper stock. For a 2" by 2" slide, make the opening no larger than 1½" square, a picture area the average color-slide projector will cover adequately. Some slide carriers have tabs that may project into this area. These usually serve no purpose and can be cut off. For a 3¼" by 4" slide, the maximum opening is 2¼" by 3".

Clean the cover glass to remove all traces of dirt, and dry. Just before binding, heat the slide to drive all moisture from the gelatin coating by laying it on a warm radiator, under a heat lamp, or near a light bulb.

Use ⅜" wide strips in taping. Have four strips, each cut to the length of an edge, or a single strip, about 8¼" long for a 2" by 2" slide. Start the single strip near the center of the bottom edge so the overlapping ends will not have to enter the projector grooves. Corners are either folded over or notched.

A PLASTIC PROJECTION REEL with a patented threading feature and a self-locking film catch is now available to home-movie fans. It has a convenient slot in one of the reel arms for the film to slip through, enabling one to thread it quickly and easily even in darkness. The film is then placed around the hub, which is open on one side to provide sufficient finger space, and is automatically locked when pulled down. Fully loaded, the reel will hold 400' of 16-mm. film.

EXPOSURE METER MANUAL. Issued by a manufacturer of exposure meters, this handy 97-page manual deals with the more scientific aspects of photography, particularly those relating to exposures. The technique of using an exposure meter is explained in considerable detail, and the text is illustrated with striking pictures by well-known photographers, and with diagrams and charts. One of these, shown at the left, illustrates by means of a tone scale across the bottom how black-and-white film renders colors as different shades of gray, ranging from almost a pure white to almost a jet black.



TRIPLE-PURPOSE PROJECTOR. Color slides, black-and-white slides, single- or double-frame film can all be shown with the portable projector pictured above. Film is held flat in the optical plane by glass pressure plates and is ready for showing again immediately after use without rewinding. The feed capacity is 300 single-frame pictures. An air blower and a heat-absorption filter safeguard slides or film against heat damage and permit the use of 300-watt lamps as well as smaller ones.

Pen Forms Handy Scoop for Photo Chemicals

FOR WEIGHING or otherwise handling small amounts of chemicals, a novel scoop can be made from an ordinary pen nib and holder.

The pen nib is placed point first into the holder, which forms a convenient handle for manipulating the scoop. With this you can place as small an amount as a crystal or a grain of chemical on the scales. It is convenient, too, for getting into small-necked bottles when spoons and all other implements prove much too large.—WILLIAM SWALLOW.

FAST, HEATLESS ENLARGER USES FLUORESCENT TUBES

Photo Editor:
Can you give me any information on fluorescent photo enlargers? I am interested in building one, but cannot secure data and plans.
W. S., Pemberton, N. J.

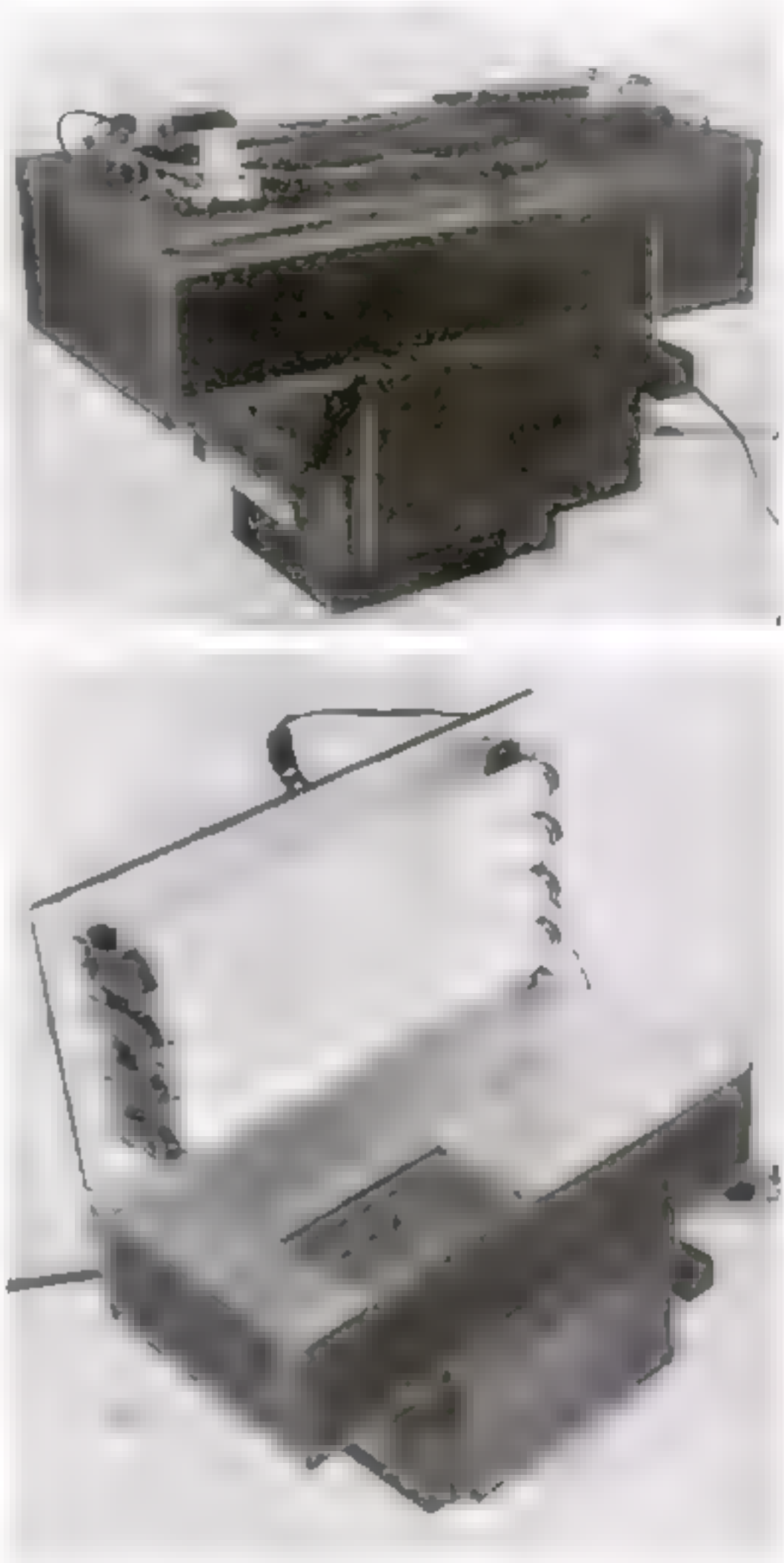
To which John W. Campbell, Jr., replies:

READER W. S. is making a good choice. The fluorescent tube comes so close to being the ideal light source for enlargers that it seems a poor compromise to use anything else in homemade ones. Fluorescent tubes give a brilliant blue-white light of very high photographic value, and are so nearly heatless that negatives can be left in the carrier of the light box illustrated for several hours and still come out cool to the touch. There's plenty of visible light for focusing, and many times the actinic value of an equivalent wattage of incandescent light.

My homemade light box was originally equipped with a 150-watt Mazda floodlamp and an opal-glass diffuser. It took 20 to 40 seconds to make an 8" by 10" print on Velour Black, and a negative would show signs of dangerous overheating in three minutes. With four 14-watt fluorescent tubes and a ground-glass diffuser, I can make an 8" by 10" print from the same negative, at the same lens stop, in 1½ seconds!

The enlarger was designed with a fixed head and a movable table; such an arrangement is simple to build, and little affected by vibration. The enlarger head is fixed to the basement ceiling beams, and the easel slides vertically on two pipe members. The camera clamps onto the bottom of the head.

If you build this type, you may as well use large tubes. Should you trade in your camera for a larger one, the light box will still be adequate, and the big tubes cost less than the smaller ones. Because the tubes themselves provide a fairly even light, a single sheet of ground glass gives adequate diffusion. The tubes are available in ½", 1", and 1½" diameters, and in 15", 18", and 24" sizes. Special 8-watt, 8" by ½" tubes may also be obtained. Daylight blue-white is the best tube color; it gives a maximum of actinic



Ballasts, sockets, and their starter buttons are mounted on the lid of this fluorescent-tube enlarger lamp. Four tubes provide a diffused light for negatives as large as 5" by 7". The box is painted with aluminum lacquer inside

light along with maximum focusing light.

The distance from the tubes to the ground glass should be approximately twice the tube diameter to assure even illumination. The ground-glass surface should be about 1½" away from the negative carrier, so that it will not be in focus when the negative is being printed. The ground glass should have at least 1" overlap on all sides beyond the negative.

How many tubes to use will be determined by the size of the ground glass. The outermost tubes should be centered above the edges of it. Mount the tubes not more than half their own diameter apart; the closer you pack them, the brighter the image will be. The 1½" tubes are naturally the best for this reason. The light box pictured uses four 14-watt, 15" by 1½" tubes, and will handle negatives up to 5" by 7".

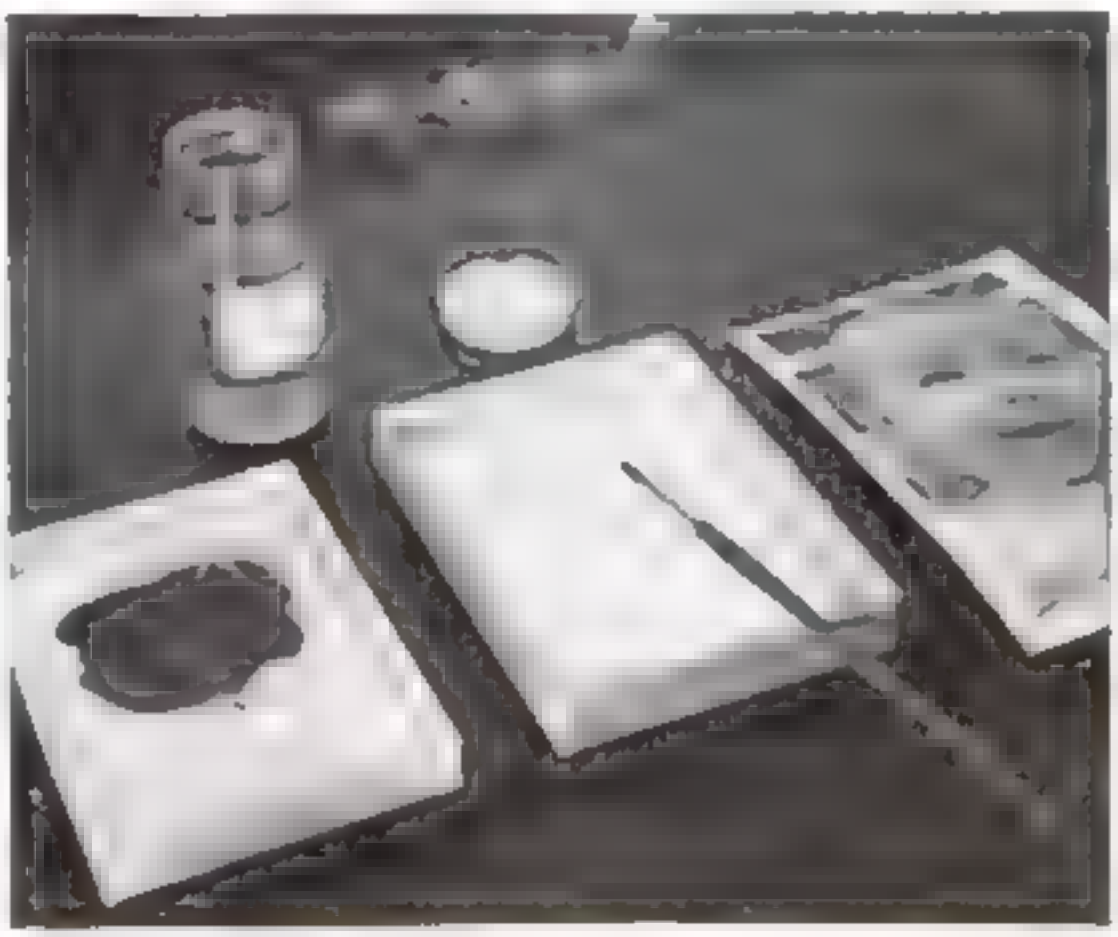
The inside of the light box is painted with aluminum lacquer, the outside with flat black. All edges are sealed with black tape. Vent holes are unnecessary with fluorescent tubes.

A drawback in the fluorescent lamp is the fact that it will not reach full intensity at once, so exposures must be controlled in another way. It is best to leave the lamp on continuously, and use a shutter mechanism to make the exposure. The simplest arrangement is a swinging arm carrying a black disk in front of the lens. On the enlarger illustrated, the arm is activated by a solenoid controlled by an electric timer.

After the war, cold-cathode fluorescent tubes will probably offer the perfect solution. Used with a high-voltage neon-tube transformer, they provide instant starting and stopping.

Flash Gun Is Adapted to Standard Plugs

OWNERS of flash guns that take special plugs for their miniature outlets are finding it difficult to get plugs. Such an outfit can be adapted simply to standard 110-volt plugs by slipping a so-called 110-volt "three-way socket" into the gun, as shown. The bulb can be screwed into this socket, and outlets are provided on each side for extensions using standard plugs.—LOUIS HOCHMAN.

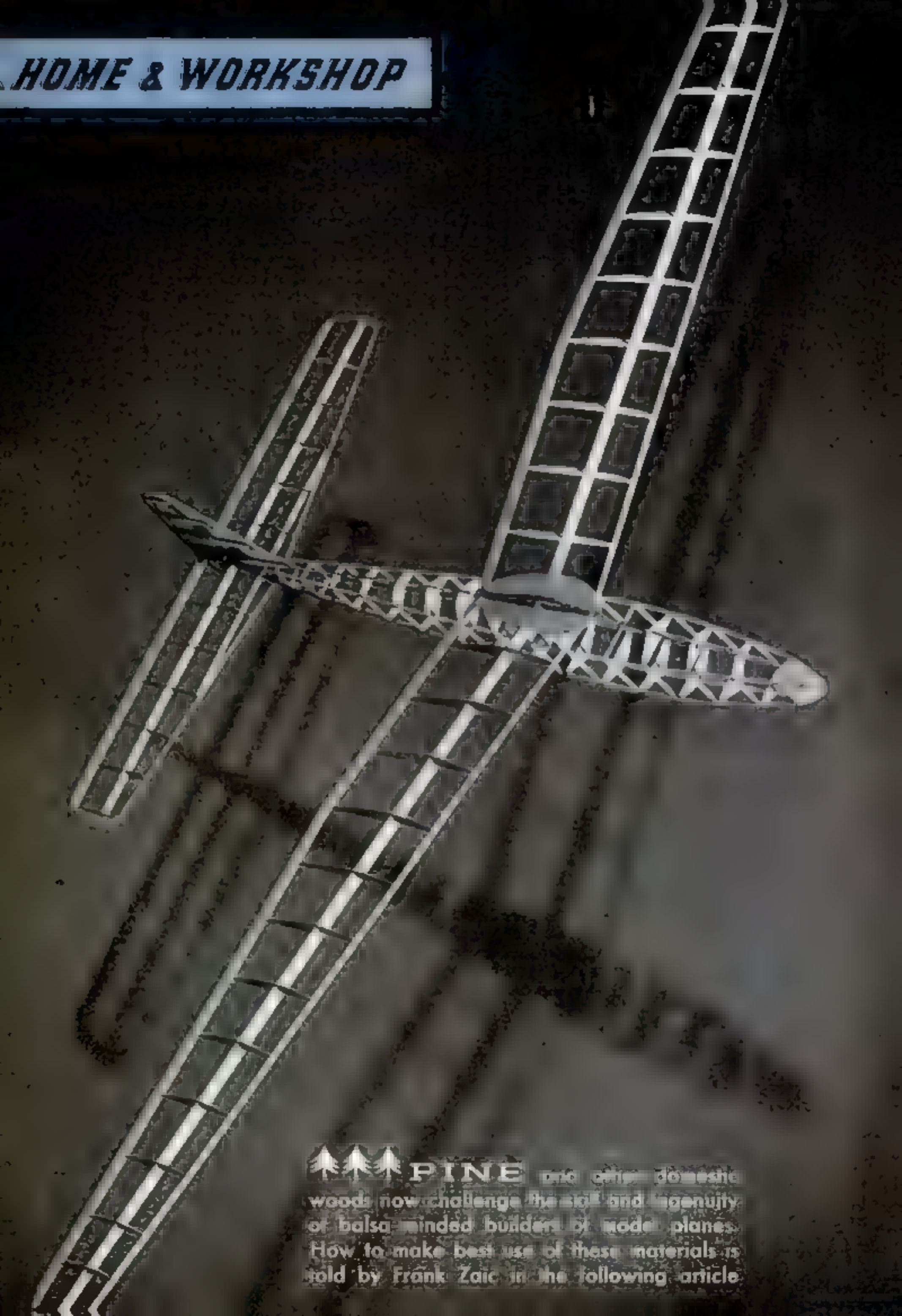


Glass Palette Fitted in Flat Box Is Aid in Spotting Prints

HERE'S an easy way to do your print spotting without staining the family china. Take a shallow box like the ones in which cut films come, and fit pieces of blotting paper to both halves, inserting them snugly so they won't slip out. Then cut a piece of clear glass the right size to go into the bottom half of the box, and you have a palette on which to smear water colors for matching print tones.

Tubes of blue-black and burnt-sienna water colors supply the pigments for mixing any desired shade. The blotter in the top half of the box may be used to point up the brush before you apply the spotting to your prints. The box can be closed when not needed and presents both palette and blotter when it is opened.

The above photograph shows the outfit ready for use, with a bottle of brush moistener handy.—C. H. COLES.



PINE and other domestic woods now challenge the skill and ingenuity of balsa minded builders of model planes. How to make best use of these materials is told by Frank Zaic in the following article

Building Model Planes Without Balsa

DOMESTIC SUBSTITUTES SERVE CRAFTSMEN AS MODEL MATERIALS MARCH OFF TO WAR

By FRANK ZAIC

WHEN war was thrust upon us, it became evident that model builders would have to do without many of the materials they normally took for granted. Rubber became very precious, and in January, 1942, the manufacture of rubber thread for model use was suspended. Steel, aluminum, and copper, used in making motors and electrical equipment, were severely restricted. Japanese manufacturers of covering tissue became our enemies. Balsa wood—so desirable in model construction because of its lightness and strength—was classed as a vital war material, and existing stocks were frozen last August.

The search for substitutes, then, is on! Luckily, domestic paper mills have been turning out satisfactory covering tissue for several years. But new rubber is definitely unobtainable, and unless you can use strips from old inner tubes for powering your craft, your modeling urge will have to vent itself in gliders and gas designs.

The restriction on balsa, however, is much more serious. One can best judge the importance of this wood to the model industry by noting that about 4,000,000 board feet of balsa were hitherto used per year. It weighs from 4 to 20 lbs. per cubic foot, as compared with 30 lbs. for domestic light woods—our best available substitutes.

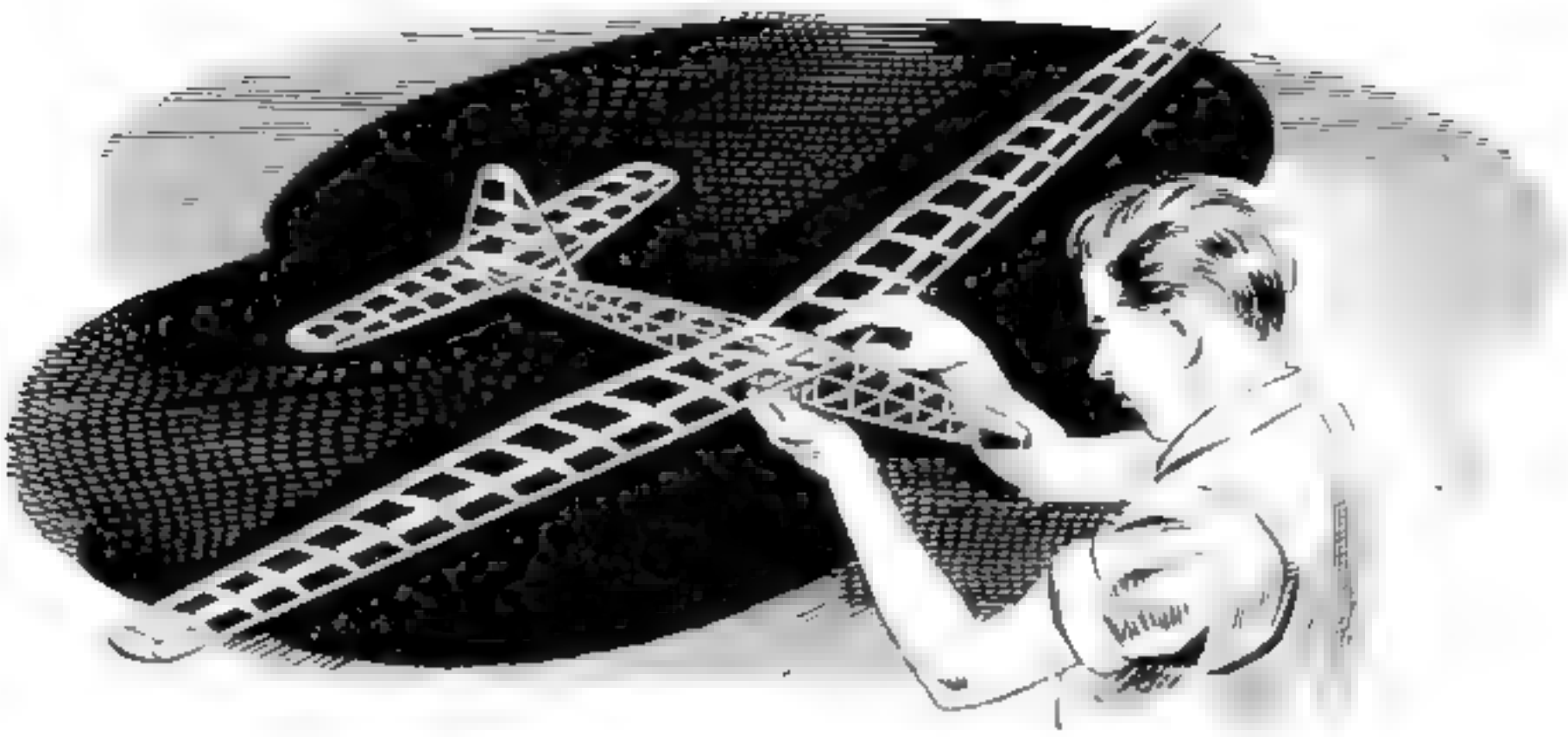
Spruce, white and sugar pine, poplar, basswood, and hemlock may be placed in this class, and of these, sugar pine seems to be the best now available for model making. It has many of the characteristics of balsa. It lacks the stringy grain that seems common to most woods, and can be crosscut without difficulty. Furthermore, it does not necessitate any variation from the aerodynamic design you used in balsa construction. As for tools, a good, sharp penknife is most important, as well as a jig saw or a coping saw with a fine-tooth blade. A block plane is essential also.

Of course, the select grade of sugar pine is now also on the priority list, but it is believed that other grades will remain available, and there will no doubt be stocks on dealers' shelves for some time to come. Most home workshops and school manual training departments, too, will have some of this material on hand. It can be ripped into suitable strips on a small power saw if a sharp blade is used and a wooden table insert with a very narrow slot is substituted so that the stock is supported right up to the blade.

Basswood promises to be the next best choice to sugar pine. It is slightly heavier—in the neighborhood of 35 lbs. per cubic foot as compared to 30 lbs. for pine. It is equally easy to work and should prove quite satisfactory. However, pine has larger "pores" than basswood, and its medullary rays (the lines radiating from the center outward) are much more pronounced, so that sheets cut along them are extra stiff and make excellent ribs.

The use of sugar pine or basswood involves no radical changes in structural design. In time we may find better ways of using it, but for the time being standard practice seems to work out very well. Pine spars and longerons will have to be smaller than those we made from balsa if their weight is to be within reasonable limits. However, the reduction should be in the thickness and not in depth, so that the beam strength will be preserved.

A wing design that proved to be good is shown on the drawing. The sheet covering the leading edge need not be more than 1/64" thick for models up to 200 sq. in., while 1/32" sheet takes care of all other sizes. This system makes possible the use of a small leading-edge spar. If the wing is small, one additional spar on the lower camber will be enough. Larger wings such as for gas jobs should have additional spars. Be sure to use sizes which have generous depth proportions. The trailing edge should have the standard tapered section. Unless the spar is placed close to the trailing edge, the covering will warp it. Some manufac-



turers supply trailing edges already shaped. If you have to cut one, be sure that it has a true taper and not just a round corner.

Most present-day designs have wings with an aspect ratio of about 8 to 1, so you can copy balsa models fairly closely in working with pine or basswood, simply making structural members one half as thick, but as deep as specified for balsa. Ribs may be cut from 1/32" sheets, provided the chord is not more than 5" and that there are several spars to prevent the ribs from weaving. Sheets 1/20" thick will do for most "B" gas designs and large gliders, while 1/16" material will take care of large "C" gas models. Some may think of lightening the ribs by punching holes in them. I do not recommend this practice, as the saving of weight will be small and the loss of strength great.

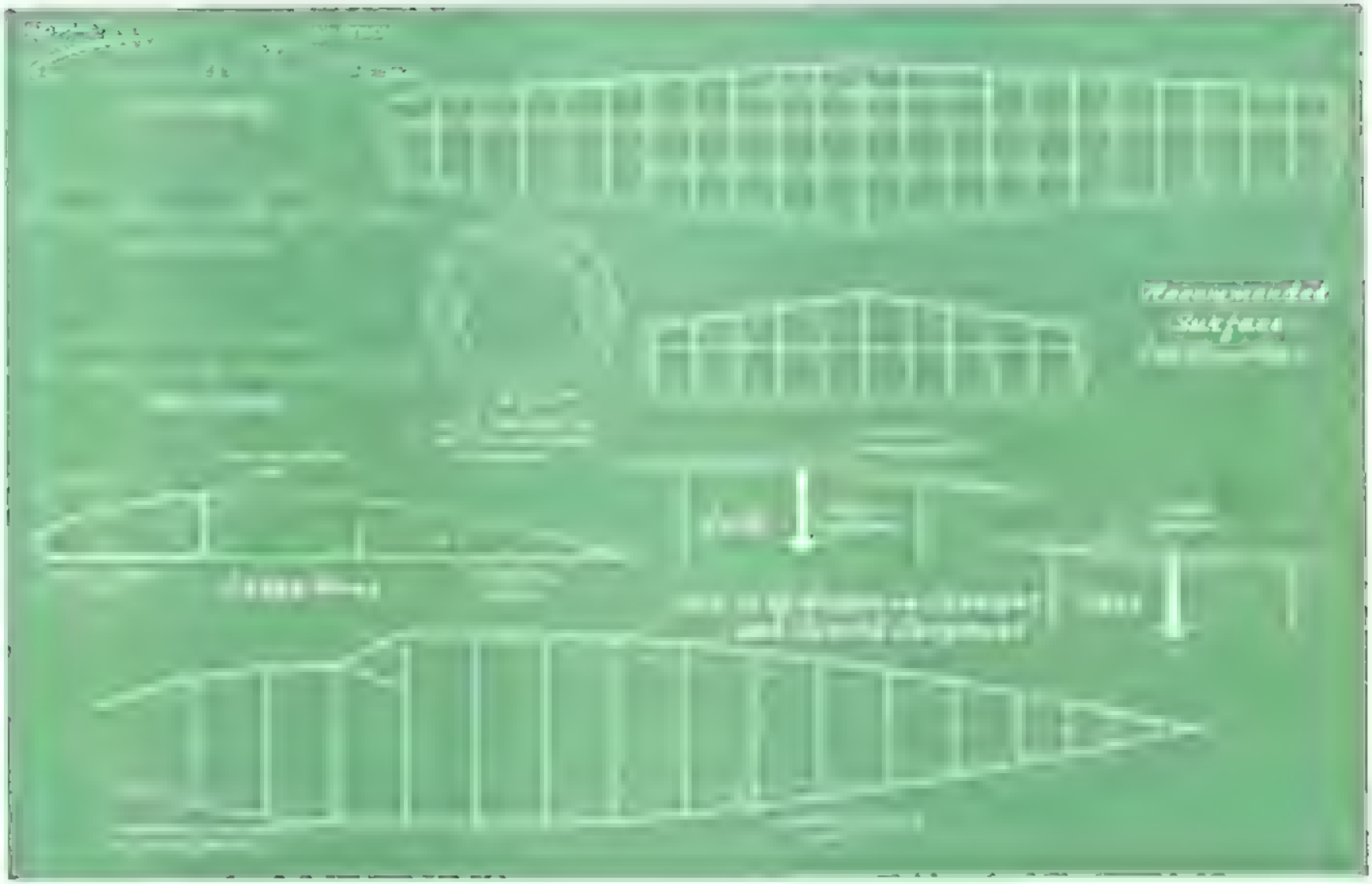
Fuselage construction, too, can be kept to established standards by the use of smaller longerons and stringers. For example, if ⅛" square hard balsa is specified, 3/32" square pine will do. It has about one half the area of a ⅛" cross section, so the weight will remain almost the same as that of the balsa member. However, the smaller pine strips will require a greater number of uprights to keep them from bending under load. To prevent buckling of longerons, the spacing of uprights should not be more than eight times the square dimension; that is, spacing for ⅛" square longerons should be 1". This can be increased, however, if the longeron is curved; therefore fuselage outlines should have a curve all along them. The covering will then keep the strip under compression, whereas if the longeron is straight the covering subjects it to tension, with resultant wrinkles and structural failures, as shown in the drawings. Note, too, how the segments of round bulkheads should be made to overlap, with deeper stringers at these points.

When using pine or basswood for longerons or spars, always consider the forces that will be placed on it, and remember that the resistance against bending is squared when the depth is doubled.

If a builder designs his own model, the ideal wing would be tapered as shown. Note that some of the spars do not run the full span. For the time being we are using simple tips that can be shaped from trailing-edge stock. Regular round or elliptical tips can be built from sections as is done with balsa, but the stock will have to be quite thick to prevent warps. Since we are only beginning to use pine, and the chief problem is to keep weight down, such fine points can well be left for later decision.

At the very outset of the search for a balsa substitute, the need for rib-making material was most pressing. Hardwood spars and longerons can be purchased ready-cut, and no work other than trimming to length is needed. But ribs have to be cut to a curved outline. I tried to cut wide sheets from sugar pine, and found that the regular balsa-sawing equipment did the job well, and that the sheets had smooth surfaces. I cut the stock to quarter grain as is done for balsa sheets intended for rib work. The crucial test came when I tried to cut the ribs out with a razor blade. I found that sugar pine up to about 1/16" thick can be readily cut this way for making ribs, bulkheads, and other flat shapes.

At first I was worried about the ability of model cement to join pine, but actual trials have shown that it can be safely used. It is, however, necessary to be generous and to go over the joints several times, extending the coating over a larger area than on balsa to obtain good anchorage. When this is done, the dope by which the covering is held in place will soften the cement at the



HW 8

joint and make it soak into the paper, thereby forming a gussetlike structure. It is recommended that work be left in the pin jig overnight while the cement is setting. Pine has more life than balsa and it is liable to break loose if the cement is not quite hard. One must not forget that model cement needs air to dry and that the surface always dries first, leading one to believe that it has set when it may still be soft inside.

The only substitute for cement, should this also become unavailable, would be casein glue. Ordinary fish glue seems never to set to a model maker's satisfaction, and damp weather is likely to loosen it up. Just what you will do for dope depends on what your paint shop has to offer. Lacquer thinned out 50 percent with lacquer thinner might be satisfactory.

To get a good idea of just how helpful balsa has been to us, one has only to look at models built by boys in Europe, who had to use hardwood all these years because of the tendency of their countries toward self-sufficiency. Although these models may be examples of fine workmanship, their aerodynamical layout makes them poor flyers and their actions remind us of our own early efforts of about 1927, when we knew very little about model aerodynamics. To our advantage was the fact that it is easy to build

or repair a balsa model in a few days and try out new ideas. A hardwood model requires more time.

This is the challenge to American model builders: Can we tackle the problems of hardwood construction, and in spite of our inexperience, do better work than European boys who have had a much more extensive background in this type of model building? I feel that our work will have many advantages. A good example is our use of thin white-pine sheets for ribs, while they use plywood, which takes much longer and requires greater effort. Perhaps they tried thin sheets but did not know that quarter-graining was necessary. At any rate, it will be most interesting to note just how our hardwood models will compare with those of Europeans. Although most of our older builders are serving in the armed forces or are at work in war industries, I am sure that the younger craftsmen will not let us down in our expectations.

It cannot as yet be foretold which of the available woods will gain the greatest favor. Some dealers will stress pine while others may feature basswood, depending on the grades produced and the nearness of supply. Although this article may have dealt almost exclusively with pine, the methods outlined also apply to basswood or other softwoods.

CONVERTING DECIMALS TO FRACTIONS [CALCULATIONS]

MANY occasions arise in the shop when decimal dimensions must be measured with an ordinary rule graduated in fractions of an inch. To determine the fractional equivalent of a given decimal, multiply the decimal by the denominator of the fraction most convenient for your use.

For instance, in laying out a sheet of light metal to be formed into 6¾" diameter pipe, it will be found that the circumference is 21.2058". The decimal, .2058, may be multiplied by any of three denominators, thus:

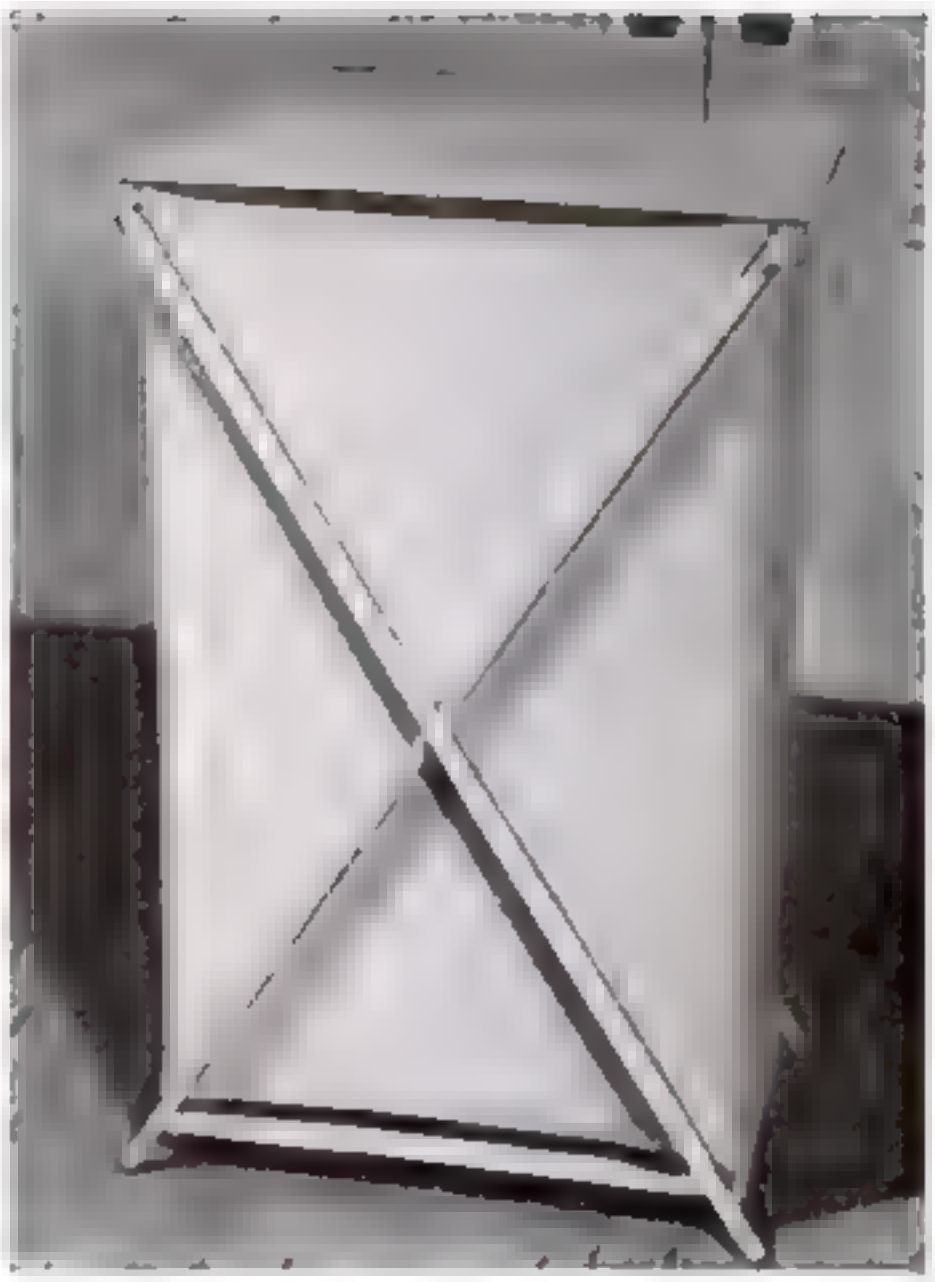
.2058 times 8 equals 1 6464 eighths.
.2058 times 16 equals 3.2928 sixteenths
.2058 times 32 equals 6.5856 thirty-seconds

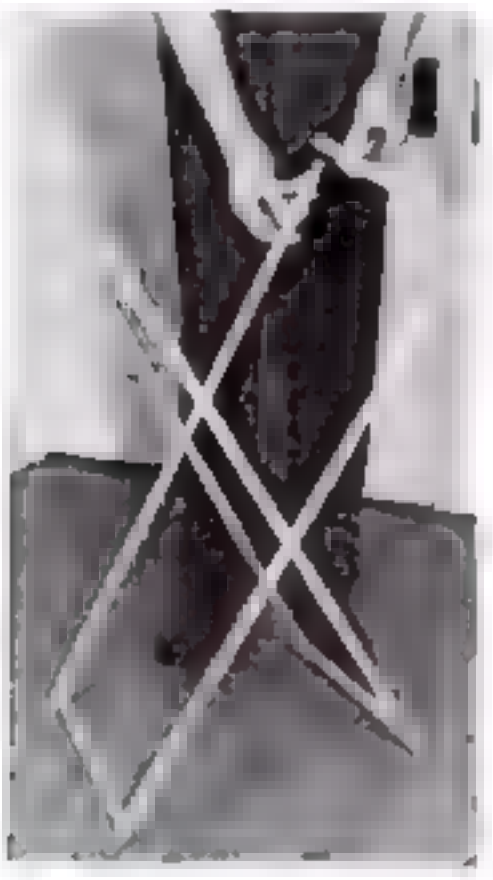
Using the last of these figures, for example, the circumference would be measured as 21 inches and 6.5856 thirty-seconds. Allowing for a slight reduction in the pipe diameter when the metal is curved, the width of the piece you lay out may be 21 7/32", exclusive of lap.

POPULAR SCIENCE MONTHLY SHOP DATA

Hop sacking or cretonne makes a colorful lid cover and bag for this light, sturdy wash-day clothes hamper

When folded, the hamper takes up little space in the laundry, and it can be easily carried back to its closet when washing is done





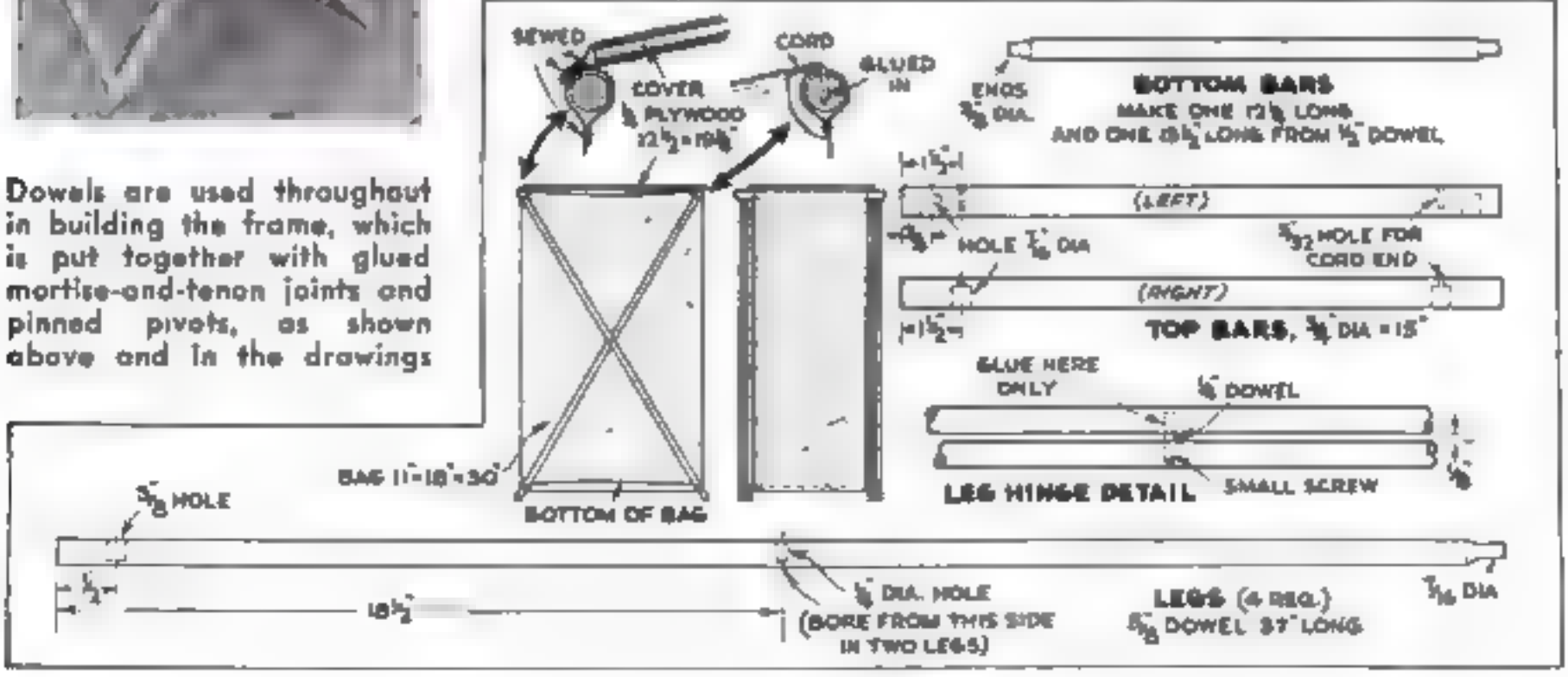
Collapsible Clothes Hamper

THIS attractive folding clothes hamper is easily carried to the laundry for sorting clothes before they are washed. The simple frame is made of dowels, while the cloth bag is so designed that the framework holds it open rigidly and, at the same time, allows it to be folded easily.

The lid consists of a piece of ¼" plywood covered with the same material as the bag and attached to the framework as indicated in the drawing below.

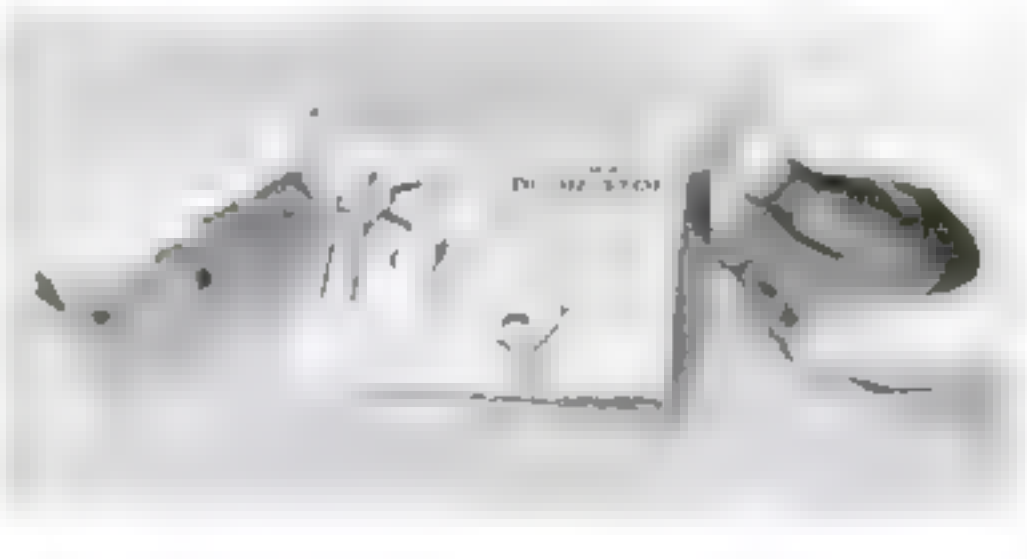
To empty its contents, the hamper is inverted. This is easy to do because of its extreme lightness.

Dowels are used throughout in building the frame, which is put together with glued mortise-and-tenon joints and pinned pivots, as shown above and in the drawings



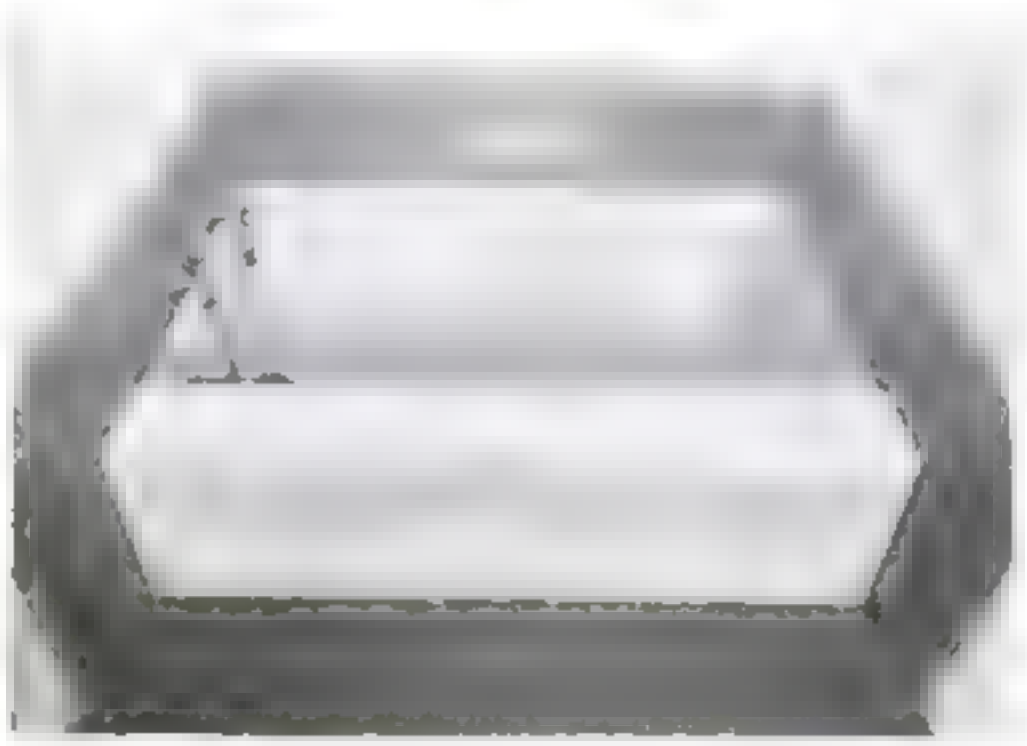
OF INTEREST TO HOME OWNERS

MIDGET DOOR STOPS that slip under the pinhead of a door hinge take the place of more elaborate ones. They can be installed in a moment by lifting the hinge pin out of the hinge, inserting the pin through the hole in the door stop, and replacing the pin. The devices can be adjusted to stop doors at a 90-deg. or a 180-deg. angle. They can be removed at any time.

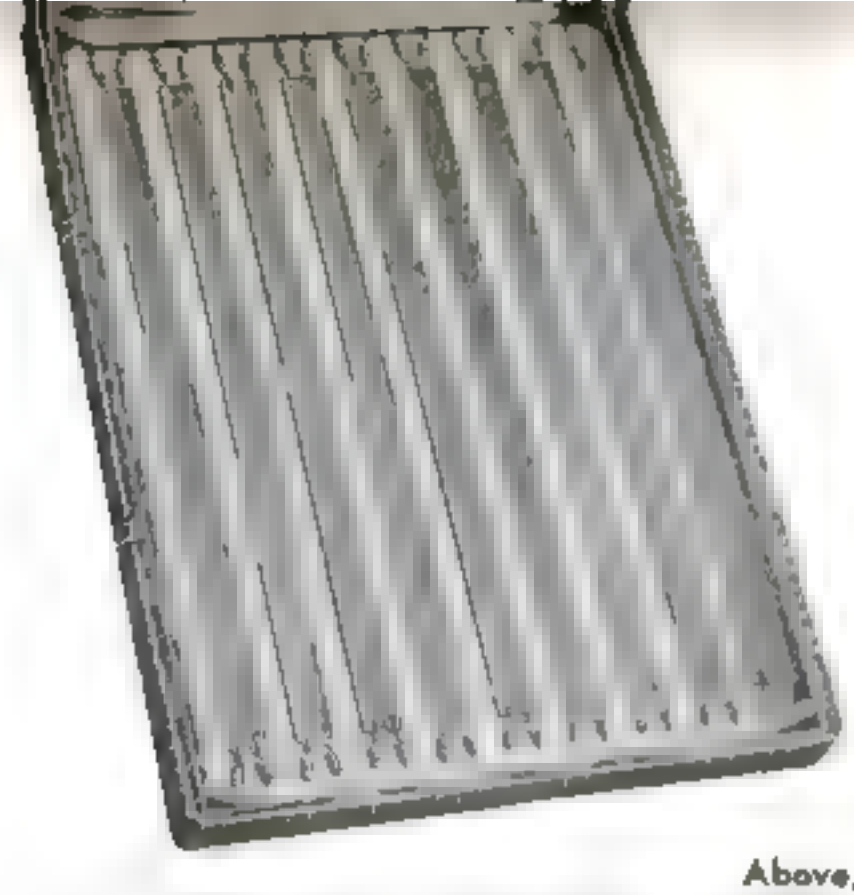


BLACKOUTS ARE CAMOUFLAGED from the inside through the use of the decorative shade above. Made of heavy black paper and absolutely opaque, it looks like a Venetian blind by reason of a design applied to its interior surface. It may be hung in place or rolled up for storage in a few seconds, and is available in four convenient sizes designed to fit almost any window in the home

TILE BATHTUBS, built on the job, may save hundreds of tons of steel and iron that would otherwise go into the making of ordinary ones. The tub shown below was constructed on a wooden framework reinforced with wire mesh. It is roomier, easier to clean, and offers a surer footing than the old type, while the wide seat at the front is a distinct improvement. The interior is composed of pieces of unglazed ceramic tile, which is available in attractive color combinations. Such built-in tubs eliminate many transportation problems, and can sometimes be installed where others could not.

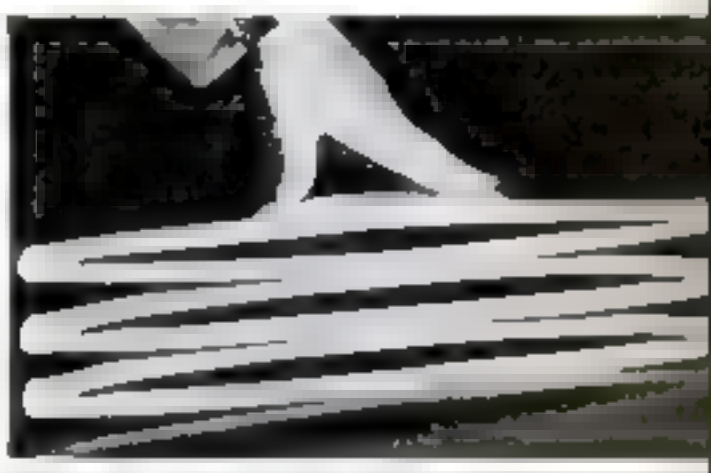


HERE'S WALL PROTECTION in the form of a transparent film that prevents dust and dirt from penetrating painted surfaces and washable wallpapers. The colorless flat finish is applied directly and dries in about twenty minutes. When walls become soiled, the film is washed off with water—no soap or cleaner is necessary—and a new coat is applied. A gallon of the fluid will cover about 1,500 sq. ft.



The full-size box spring above requires only 5 lbs. of steel. Instead of coil springs, there are ten birch slats, each 3" in width, suspended from double helical springs held by wire clips

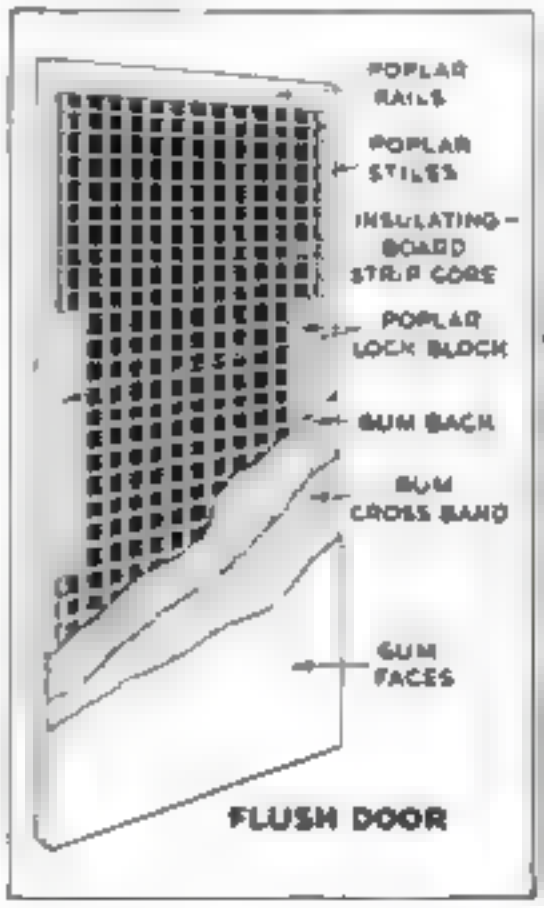
Above, bedspring made of hickory slats, rope, glue, and nails! Right, spring bandsawed from one piece of wood. Right, below, four experimental types of springs. The large spiral one shown is of plywood

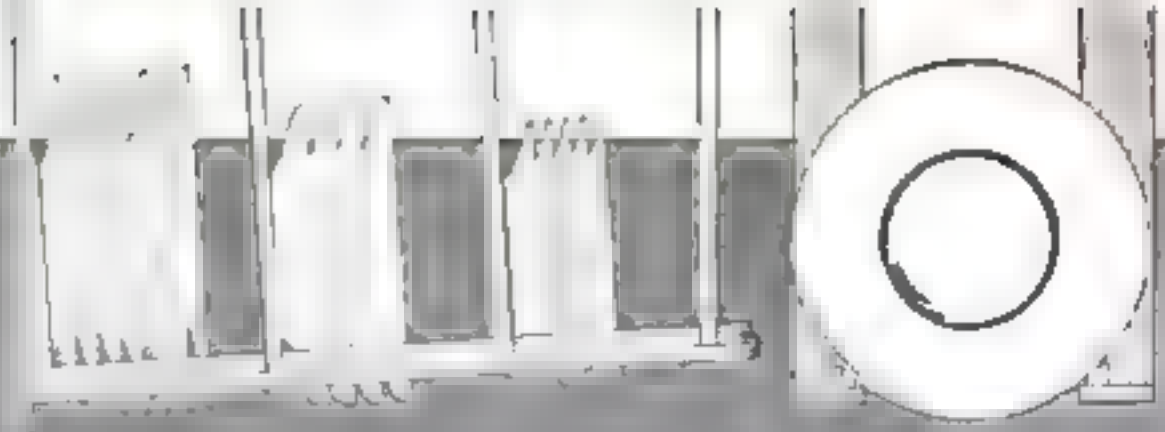


WOODEN FURNITURE SPRINGS may solve the problem raised by restrictions on the use of steel for such purposes. Experiments are being made with various types, one of these being a wooden bedspring which can be adapted to couches, chairs, and so forth. The resilient members are made of hickory, treated with a wood preservative, but not steamed or bent in any way. Oak, ash, and maple springs also are being tested. One manufacturer has combined wood with steel to make a full-size box bedspring, containing ten birch slats suspended from helical springs at both ends. The total amount of steel used, including that for the wire saddles or clips by which the slats are attached to the springs, is only 5 lbs.

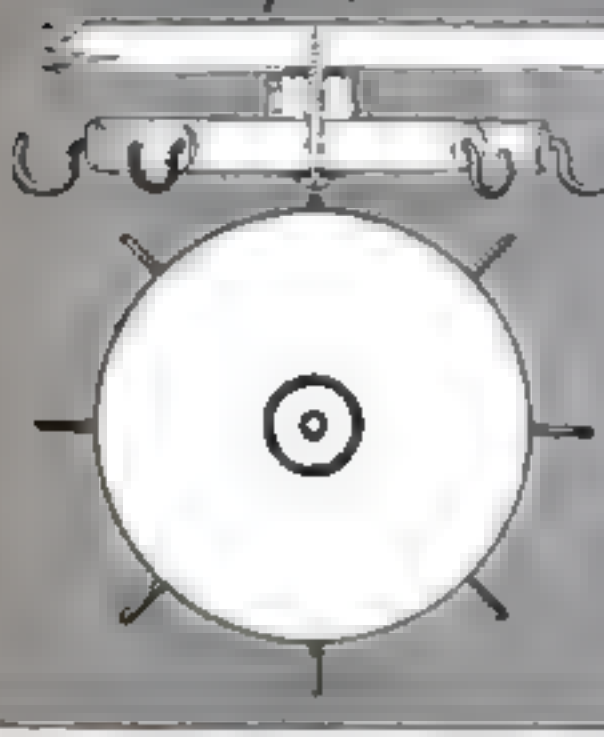
FLUSH DOORS add new modern beauty to any home. A honeycomb grid between the faces is said to make the type shown below unusually sturdy. The grid consists of strips of insulating board halved together to form a rigid, nonwarping core. Frame corners are made with wedged dovetail joints. The faces are composed of three-ply gum veneer, and completely seal in the core. All parts are fabricated with water-resistant resin glue, which fixes the two faces firmly to the frame and core.

Below and at extreme right, flush doors displaying the clean-cut lines and simplicity so desirable in modern homes. In the drawing, a cross section of the door shows the honeycomb core and the frame and face construction





Cup Holder



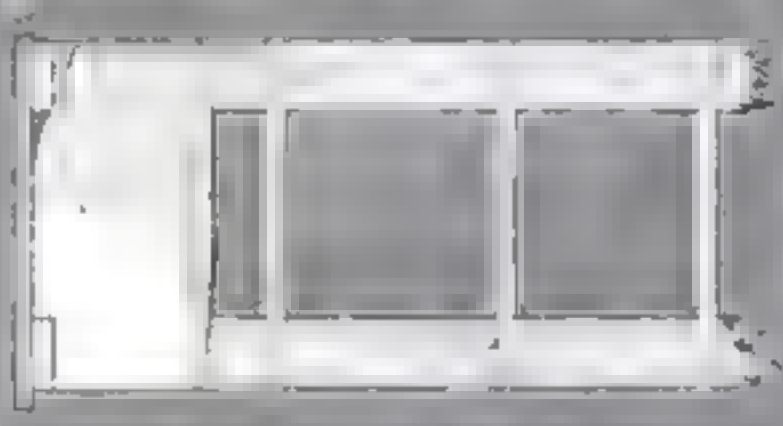


Plate Rack

STORAGE UNITS FOR THE

HW 8

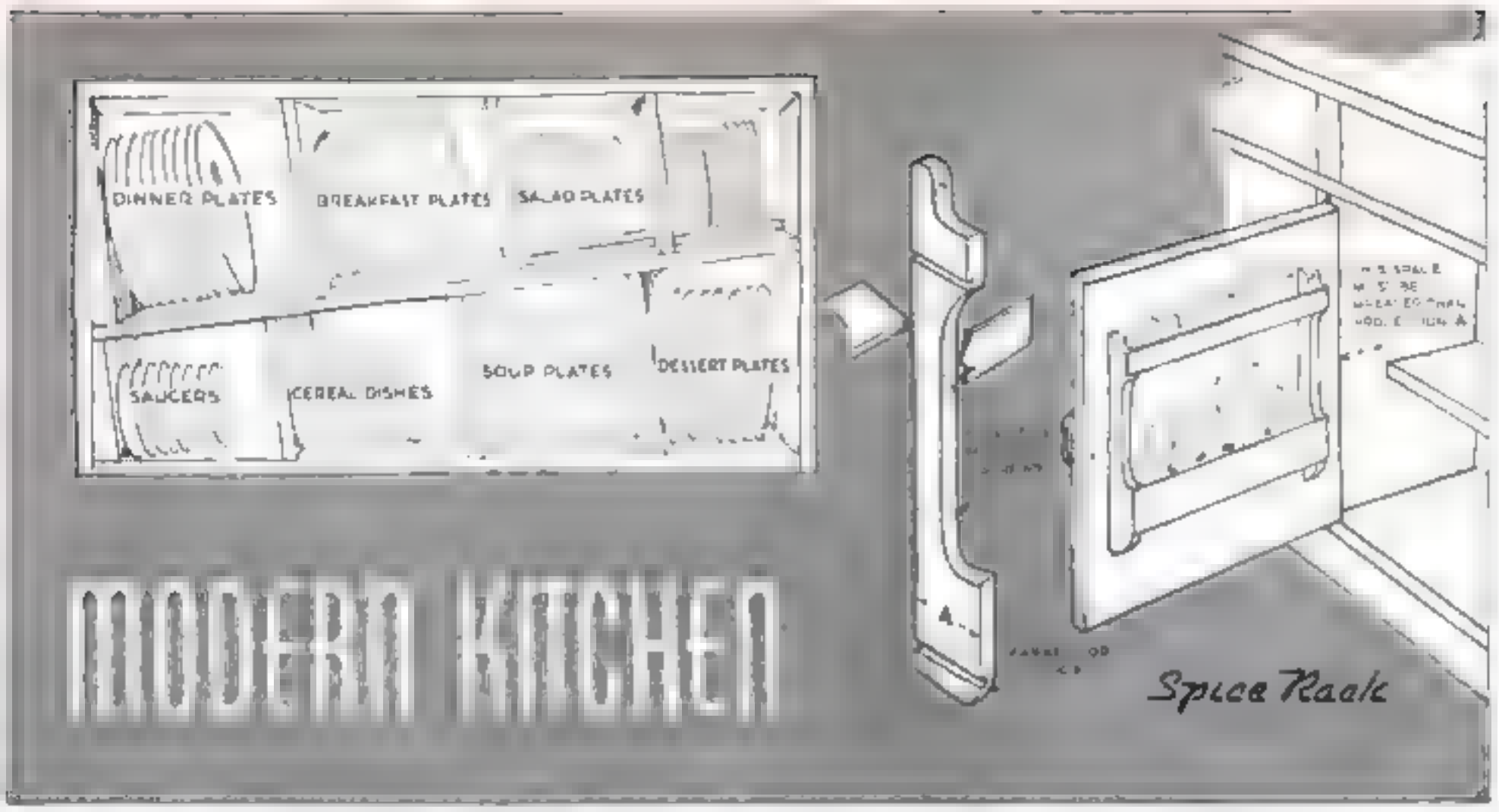
By JOSEPH ARONSON
Interior Designer

FOR complete modernization of a kitchen, a systematic method of storing equipment in use every day must be provided. Whether you are making a fresh start by remodeling, or already have some up-to-date units installed, it will pay to give additional thought to timesavers of this nature. Here are suggested designs, adaptable to the space you have available, for a pot closet, spice shelves, tray rack, revolving cup holder, and plate rack.

Pot closet. The old method of storing pots and skillets in low cupboards necessitated stooping and searching. A narrow closet taking less floor space will hold all ordinary pots in open view and within easy reach. One 15" deep by 24" wide and reaching to the ceiling will be sufficient. Put it near the stove. To plan the hanging arrangement, cut a plywood panel at least ⅜" thick to fit into the back of the cupboard. Lay it on the floor, and group the utensils in staggered order to utilize all space. Ball-tip screw hooks are the best hangers.

Pot covers may be kept in racks on the inner side of the door. Strips ¼" by 3" are screwed to tapered cleats, leaving about ½" open at the bottom. The covers wedge themselves in and will not rattle.

Spice shelves. Disorderliness of small articles in a deep cupboard can be avoided by fastening shallow shelves to the inside of the cupboard doors. One of the sketches shows a type suitable for small packages and shakers of spices and small bottles of condiments and sauces. End-pieces shaped as suggested may be sawed out to support two or three shelves. Both the shelves and fronts may be of ¼" plywood. Rabbet the



MODERN KITCHEN

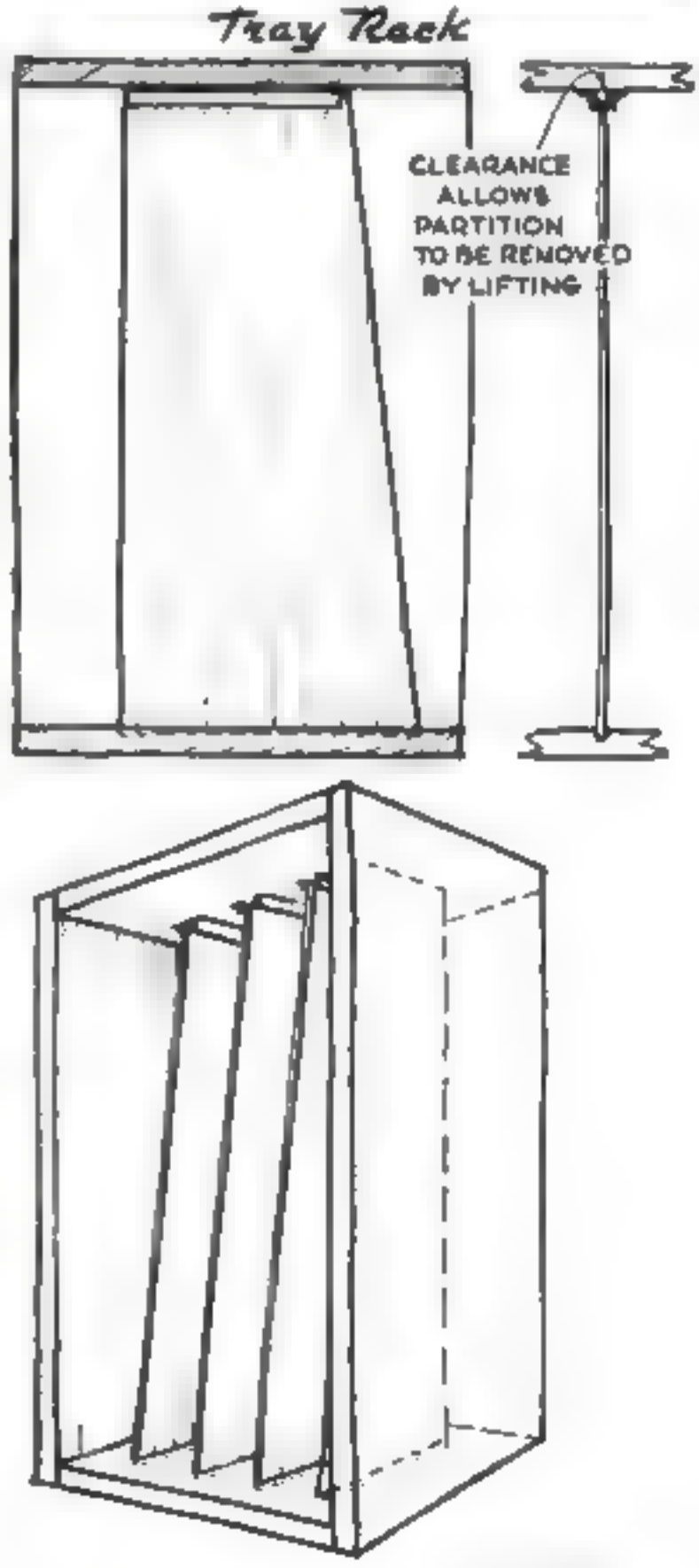
floors into the endpieces, nail or screw the fronts on, and screw the assembled rack to the door. Size is best determined by arranging all the articles to be stored in rows according to height. The most important detail is to cut back any cupboard shelves that may otherwise interfere with the closing of the doors.

Tray rack. Trays may be stored vertically, thus occupying some odd corner of unused space either high or low. The dimensions should be based on the largest tray in your collection. All trays should be kept separate by partitions of ¼" plywood or composition board, each set loosely into a groove in the floor of the rack and supported at the top by two short pieces of molding. Do not let the partitions go all the way back. They are easily removed for thorough cleaning.

Revolving cup holder. Eight cups may be stored in a small space on a 6" diameter revolving disk of ¾" plywood. Attach the cup hooks horizontally to the rim of the disk. Then fasten the disk to the underside of a shelf, using as a pivot a long screw passed through a small wooden collar and two iron washers as shown.

Plate rack. A system of storing plates on edge instead of flat not only saves space but reduces the danger of chipping. The usual way of piling plates means china on china, while in this rack we have the weight of the china resting on wood. Into the dish compartment, fix a pair of parallel stretchers at an angle of about 10 deg. and about 5" apart. Partitions should not be vertical, but at right angles to the stretchers, so that the dishes may lean against them. Space the partitions after measuring your dishes, but make allowances to avoid tight fits.

A 1⅛" cove molding placed to support the dishes at the edges as shown is helpful, as is also the use of weatherstripping as padding.



Colonial Plant Boxes

WALL HOLDERS MADE FROM A CHOPPING BOWL

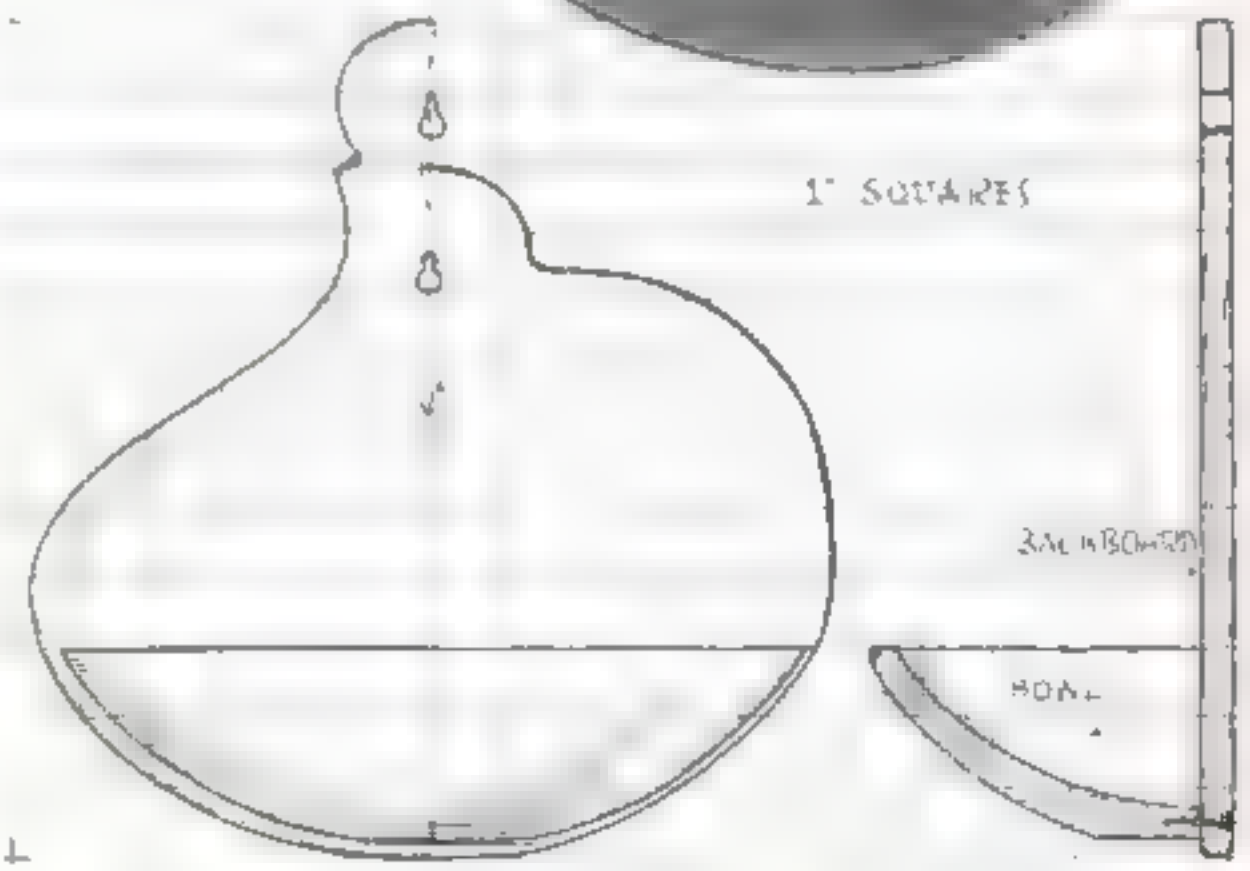
By
JOSEPH
ARONSON

A PAIR of attractive wall holders for ivy or other potted plants can be made from one wooden chopping bowl and a little ½" lumber. For the two designs shown, a bowl 11" in diameter and 2¾ deep was sawed in half with the grain, and each half was fastened to a wooden backboard with wood screws.

Two back profiles are shown, but if the plant boxes are to be hung close together, they should preferably be made to match. Use solid stock for the backs, rounding the edges, and cut an inverted keyhole slot in each to hang it up by.

Wooden chopping bowls are usually heavily waxed, and for finishing it is necessary to remove this wax with benzine. Stain both the bowl and the back panels fairly dark. Wax when dry

Small flowerpots can be kept in place by filling the space around them with fine gravel or sand. To protect the inside of the bowl against dampness coat it with paraffin or fit a metal liner of tin-can stock.



Lay out the backboards on 1" squares, following either of the two attractive designs above. Saw out the outline and round the edges all around. Saw a chopping bowl in half with the grain, and attach each of the halves to a back by means of countersunk wood screws

Crescents and a circle make a lovely frame for lovely reflections, and add a modern decorative touch to this mirror

By

FRANK PIZARRO

Occasional Mirror

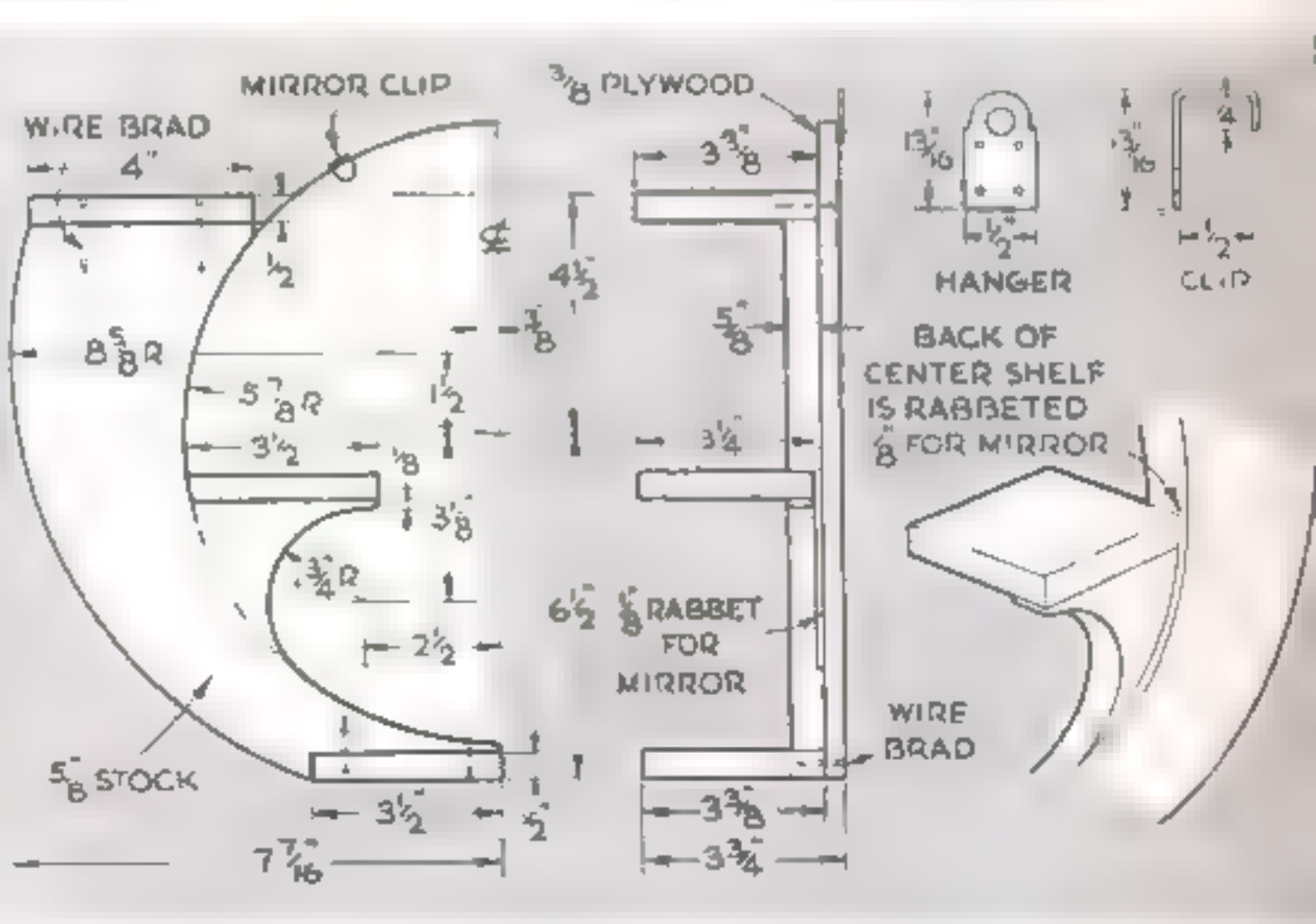
Has Three Shelves for Displaying Knickknacks

DESIGNED on simple, sweeping lines, this decorative mirror harmonizes well with modern furnishings. Making it is a comparatively simple job, although the work must be carefully laid out. The dimensions given are for an 11¾" mirror

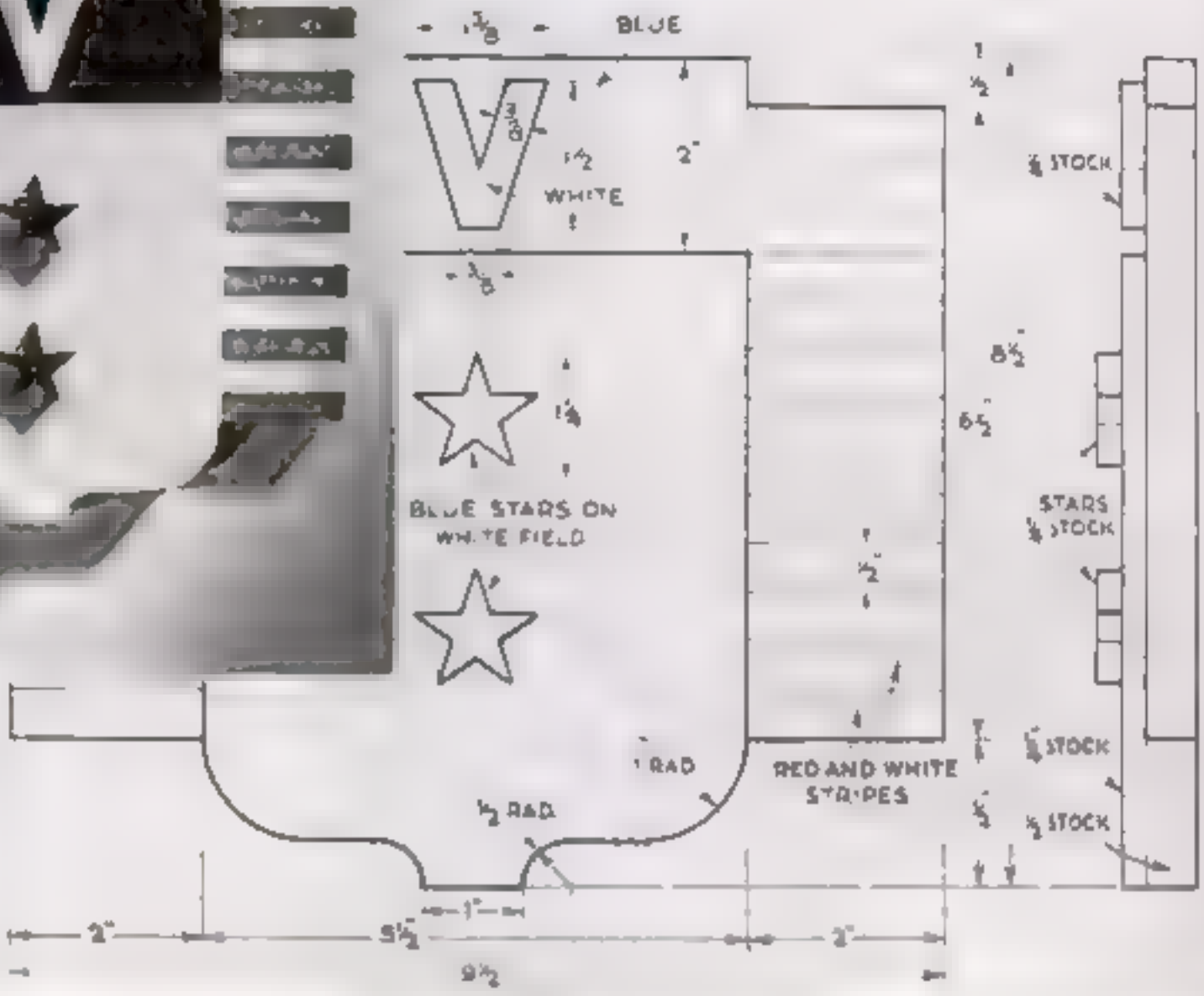
It is simplest to use a paper pattern, which will serve for both the main parts. Draw a circle the exact size of the mirror, and mark on it a diameter. Measure up from the center and to one side of the diameter, as shown in the accompanying drawing, to locate the center for the 8⅝" radius of the shelf support. Similarly, locate the center for the 1¾" radius for the projecting curve of the middle shelf. Mark off the top and bottom of the shelf support by measuring from the original center.

Cut a ⅝" plywood back to the over-all outline of the pattern. The shelf support can be cut from ⅝" or even ⅛" stock. It is notched for the bottom shelf. Working carefully with a chisel, or with a routing bit in the drill press, rabbet the back of the middle shelf projection to the thickness of the mirror. Nail and glue the two parts together; then fit the three shelves in place with a little glue and a few brads. Countersink the brads and fill in the holes.

A mirror clip and two hangers can be bought or made from thin sheet metal. The piece may be given a stain and varnish finish, but colored enamel or lacquer is appropriate for modern decorating schemes



★ ★ ★ VICTORY SERVICE

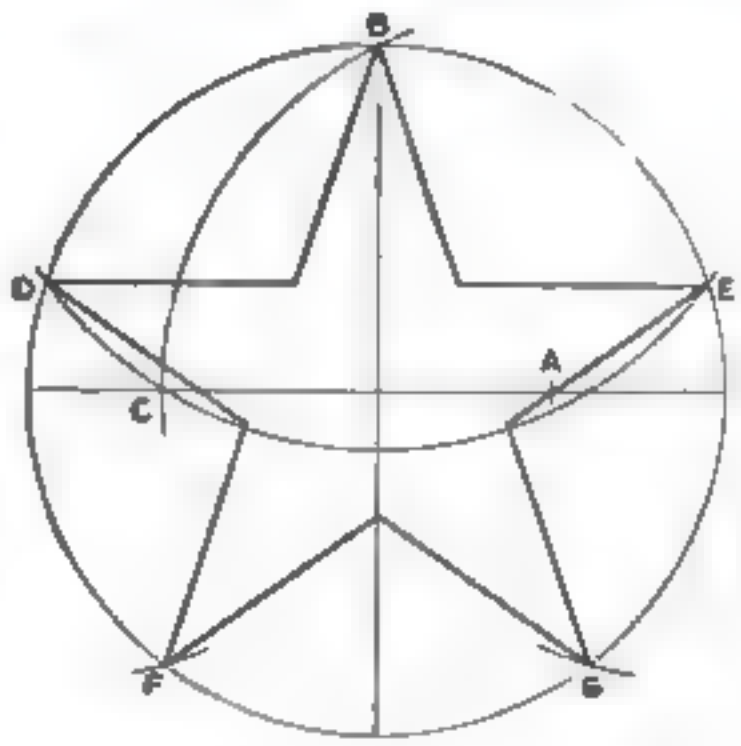


Patriotic plaques strike a timely note in the star-spangled manner

★ ★

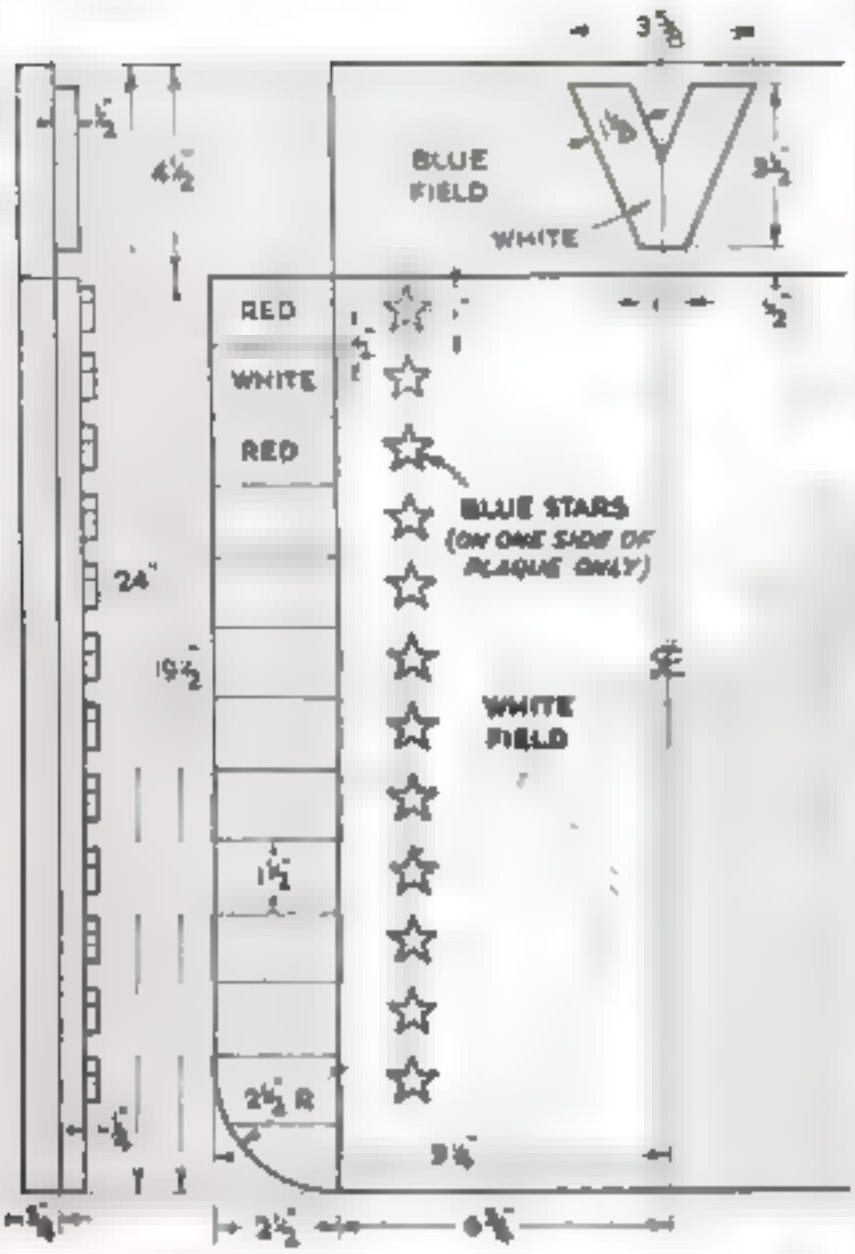
DRAWING A FIVE-POINTED STAR [SHOP PRACTICE]

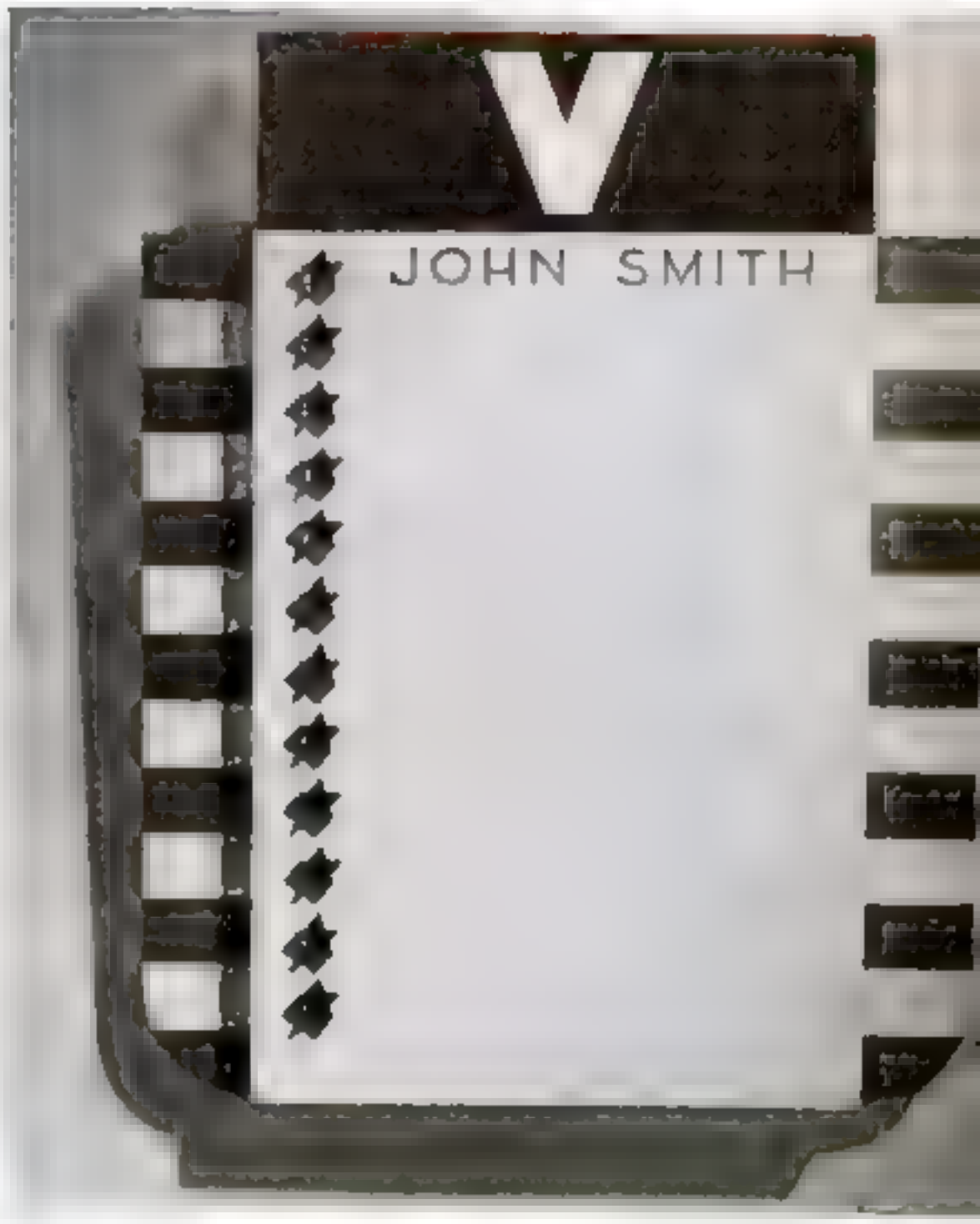
1. Scribe a circle the size of the star required.
2. Draw two diameters perpendicular to each other.
3. Divide radius in half at *A*.
4. Set compass from *A* to *B* and swing arc *B-C*.
5. Set compass from *B* to *C* and swing arc *D-C-E*.
6. With same radius, mark off *G* from *E* and *F* from *D*.
7. *F-G* should be equal to *B-E*, *E-G*, and so forth.
8. Connect alternate points with straight lines to obtain star.



POPULAR SCIENCE MONTHLY SHOP DATA

PLAQUES





★ ★ ★ BY JUAN OLIVER

FROM thousands of American homes, offices, shops, and factories, men have gone forth to join the armed services of the United States. "Let's not forget them" is the slogan of those who stay behind, and to this end service flags and plaques of various kinds are displayed.

In a letter to POPULAR SCIENCE, R. J. Lamberth, of Chicago, Ill., writes that he is kept constantly busy in his home shop turning out wooden service plaques for clubs, fraternal organizations, and business houses, and he suggests that a suitable design for such pieces might be of interest to many readers. Illustrated on this page are two attractive plaques in modern styles appropriate for home display or as company honor rolls.

The plaques give an interesting relief effect, yet are easy to make either with or without power tools. Working to the dimensions shown, cut the back of the smaller one from ½" stock, saw the raised middle section out of ¼" material, and glue or nail these together. The "V" and stars are jigsawed from ¼" stock. Finish separately before mounting these with brads. Stars can be made any size desired and spaced according to the number to be mounted.

Use ¾" stock for the back of the large plaque. To this, glue and nail the ½" thick center section. Cut the large "V" also from ½" material, the stars from ¼" stock. The names can be lettered on or cut from ⅛" stock. Pressed composition board is excellent for small cut-out letters, as it does not splinter.

Clear white pine or plywood is suitable for such plaques, but for outdoor use plywood must be the waterproof resin-bonded type. Use a good quality of red, white, and blue enamel. Masking tape will be of help in painting the stripes.

The five-pointed stars, which add to the decorative effect of these plaques, can be laid out on ¼" stock in accordance with the diagram shown on the opposite page, and cut out with a jig saw.

A stand like this is a useful accessory for your home. You can build it of wood to match other room furnishings, or finish it with a contrasting enamel.

The stand when compactly folded, ready to be tucked into a closet. Notice how little space it takes up

Folding Luggage

Holds a Guest's Suitcase for Easy Packing and Unpacking

SOLVING the problem of where to put suitcases for packing and unpacking, this sturdy luggage stand saves wear and tear on bedspreads and furniture, and folds so compactly it takes up little room in a closet when not needed.

Although the one shown was made from walnut, any strong, durable wood can be used. The bottom spreaders are turned to the dimensions shown, with ½" dowel tenons at the ends. Note that the top turnings are alike in length, and that the dowel holes are spaced 18" apart in one, but only 15⅞" apart in the other. Both bars have blind grooves or saw kerfs cut in them to take the webbing, and these are at right angles to the dowel holes.

Band-saw the four legs all to the same pattern from 1" by 2" stock. Bore a 1⅛" hole through the upper end of each; then saw across the diameter of the hole, rounding the cut slightly. Be careful in boring the ½" dowel holes for the hinge pins and bottom spreaders. In two legs these are bored from the same side of the piece, but in the other two the hinge hole is bored from one side, that for the spreader from the other.

Assemble the inner frame with glue, insert the hinge dowels, place the outer legs upon them, and assemble the outer frame. Be sure the top bars are glued on with the slots facing out. Finish the wood as desired.

Cut three 18" lengths of 2" wide webbing, which can be bought at large hardware and upholstery shops. Push the ends into the saw kerfs, and secure them with small hardwood wedges 1/16" thick driven in alongside.—BENJAMIN NIELSEN.

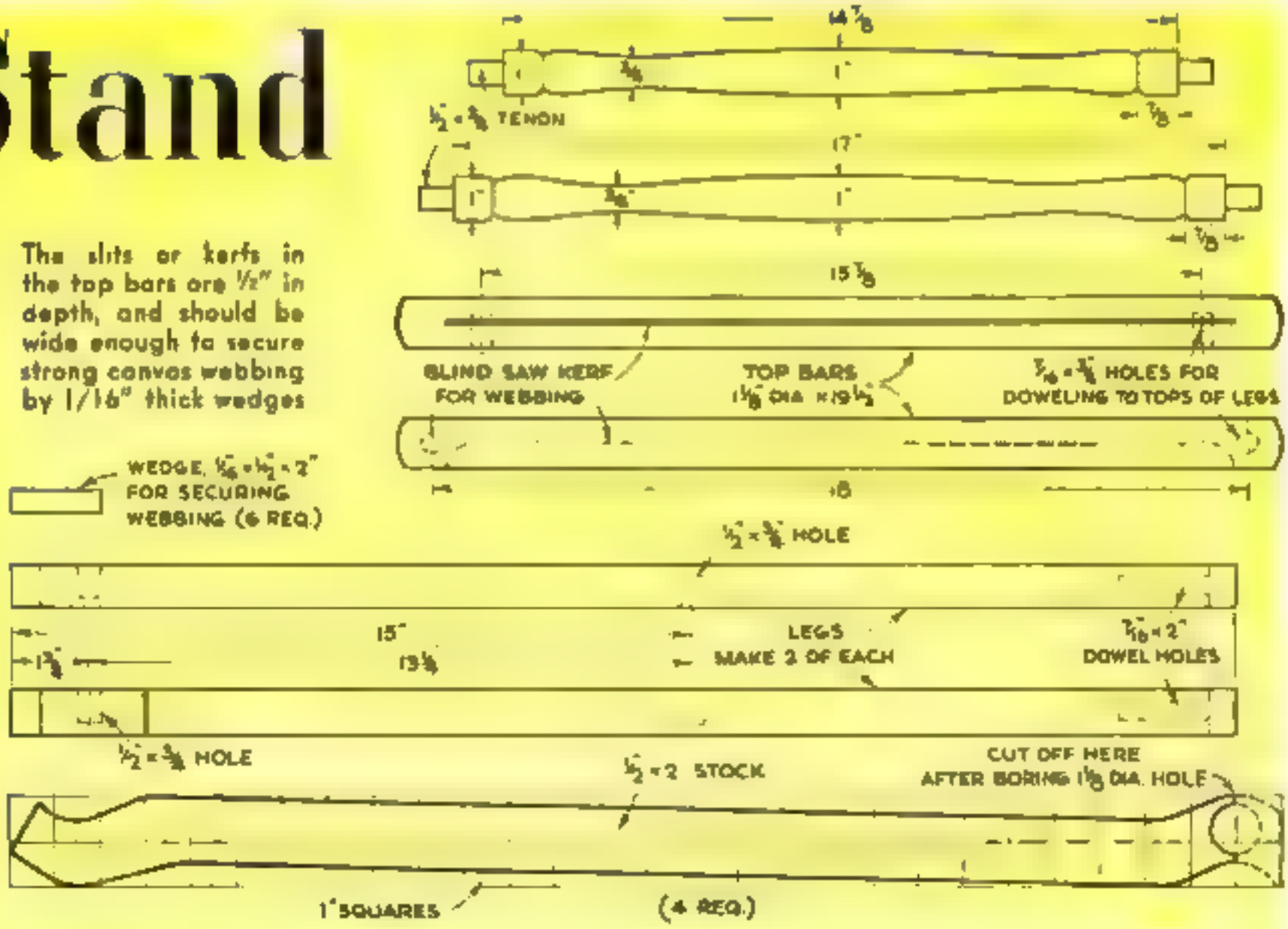
After a hole is bored into the upper end of the leg, the stock is sawed across to form a semicircular socket

Above, how a pair of legs is joined by means of a hinge pin slipped into blind holes. These are bored in the two pieces so that they face one another

Below, legs are doweled to blind holes in the top spreaders. Webbing is wedged and glued into grooves

Stand

The slits or kerfs in the top bars are ½" in depth, and should be wide enough to secure strong canvas webbing by 1/16" thick wedges



Bindings, sports equipment and all leather articles respond favorably to good treatment and will reward their owner with longer wear and fine appearance

Heat supplied by a reflector lamp allows the oil to work itself into the leather without burning. Use an infrared type therapeutic lamp or radiant heater

9 LIVES FOR YOUR

IF A SOCIETY for the prevention of cruelty to leather were formed, there is no doubt that many of us would be found guilty of abuse and neglect. These days, however, careful maintenance is the watchword for all goods that cannot be conveniently replaced, and leather—one of the oldest and most useful materials known to man—may have its life multiplied many times over with proper treatment.

Leather articles will, in spite of all care, become dirty. In the days when it was plentiful, rubber cement could be used to remove some kinds of dirt from fine leather surfaces. The cement was painted on the leather, left to dry for an hour or so, then rolled off with the fingers, taking the dirt with it. The rubber particles could be saved, dissolved in carbon bisulphide, and used again.

A wide variety of leather articles such as gloves and belts may be cleaned by washing them with water and saddle soap, Castile, or any similar mild soap, then rinsing well, and drying. However, drying leather calls for a word of caution. Did you ever get your shoes wet, dry them on the radiator, and then wonder why they felt like wooden clogs the next time you wore them? A quick way of ruining leather is to dry it rapidly with heat or direct sunlight. Heat causes stiffening and cracking. The safest procedure is to place the wet article where a draft of air strikes it—in an open doorway, for example, or in the air stream of a fan. After drying, it is a good idea to applying polish or other dressing.

Some time ago a group of scientists and library experts made a study of leather-bound books, and they found that those handled every day lasted much longer than those that remained undisturbed for long

LEATHER GOODS

periods. The reason was that oil transferred from the hands to the book bindings —an insignificant amount—acted as a dressing for the leather.

Leather must be "fed" at intervals with oil or grease if it is to give maximum service. The oil added to it in the manufacturing process will in time disappear through evaporation or other action; if it is not restored, the leather becomes dry and stiff, cracks, and often disintegrates into powder. After cleaning leather by washing or some other process, application of a dressing is always advisable.

There are numerous leather dressings on the market. Any good shoe polish will keep leather in good shape. However, leather authorities recommend that only a polish that dries to a dull finish be used, or one that has to be buffed to a luster.

When it is desired to feed the leather rather than to polish it, a dressing that consists essentially of oils and greases is most suitable. Dealers in shoe supplies usually handle such grease, but you can make your own preparation. A paste that I have used for a number of years on book bindings and other leather articles consists of 3 oz. of neat's-foot oil and 2 oz. of lanolin, by weight. Warm the mixture until the lanolin is distributed evenly through the oil, and use it warm. Apply it to the leather with a cloth, but do not put it on too heavily. Then place the article in a warm (but not hot) place to drive the preparation into the leather

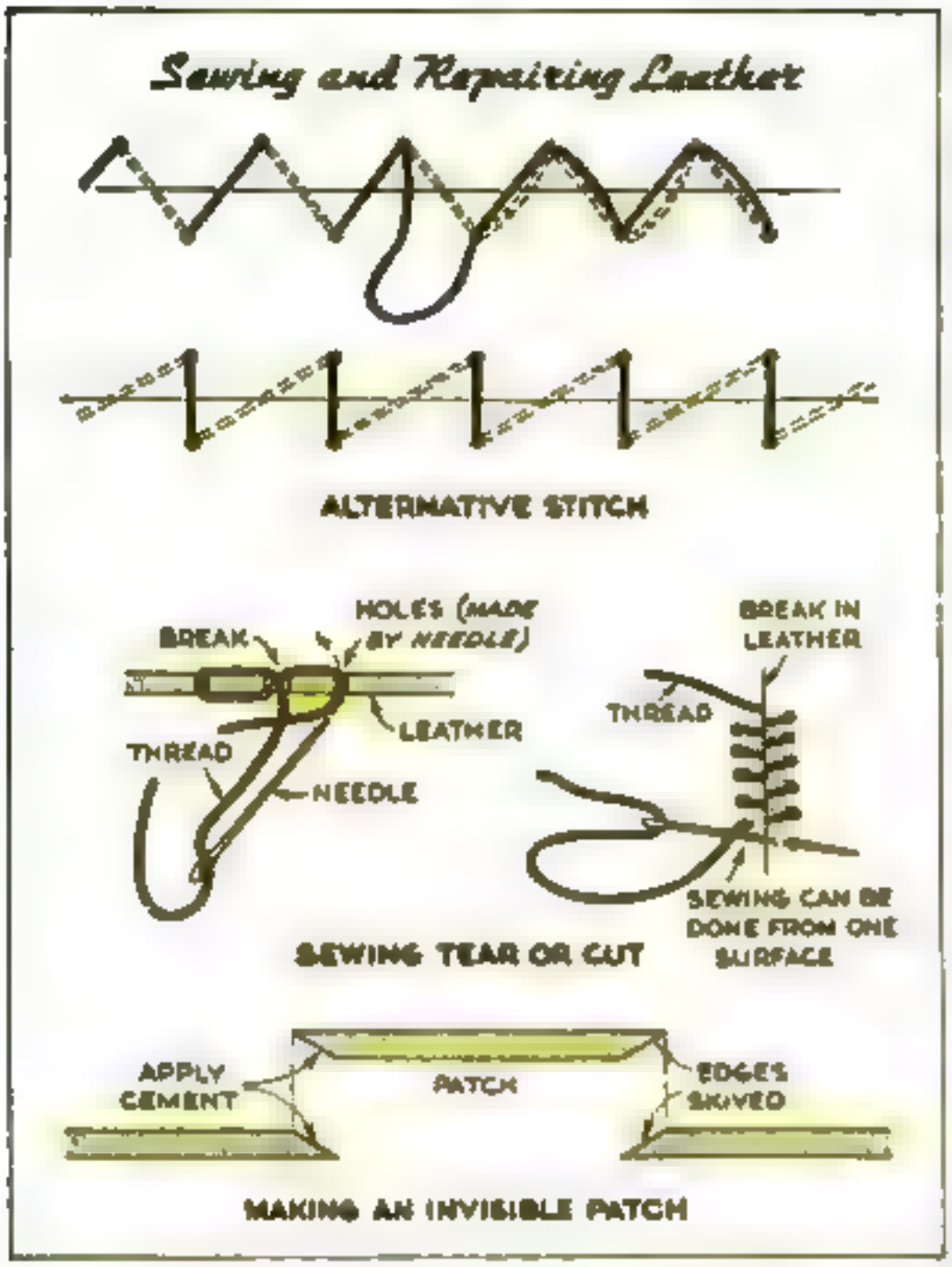
Another lubricant used in libraries consists of a mixture of castor oil and paraffin. Enough for a considerable number of books is made by heating 3½ oz. of castor oil and adding 1½ oz. of paraffin chips. Stir until the wax melts and blends with the oil. Apply lightly about once a year. The castor oil may be of the odorless variety.

A third leather lubricant is ordinary petroleum jelly. All of these dressings can be used on other leather articles as well as on book bindings.

The committee that investigated the preservation of leather bindings unearthed a lot of other facts. Books last longer if stored in open shelves not placed against the wall. Gas fumes, which create sulphuric and sulphurous acid in leather, are injurious. Likewise harmful is tobacco smoke, which contains ammonia. This provides sound reason for those "No Smoking" signs in libraries. Books kept in a damp place are likely to mildew. Those kept in closed cases should be removed and aired occasionally on dry days.

One man who hates to wear rubbers uses a commercial leather paste to waterproof his shoe soles. He smears the grease liberally on the sole and drives it in by baking, being careful to heat the leather no more than necessary. He used a soldering torch until he discovered recently that the new drying lamps and the older infrared therapeutic lamps would do the job without the danger of scorching the leather. Two or three treatments make his shoe soles water resistant for several months and improve their flexibility and wearing qualities.

Other lubricants used for making shoes and other leather goods water resistant are neat's-foot and sperm oil. The leather, particularly the soles, is well impregnated with one of these oils; then the shoes are set aside until the oil dries, after which they are polished. Neat's-foot oil dries a little



more slowly than sperm oil. There are on the market various waterproofing preparations that can be used in a similar way.

One of the best methods of prolonging the life of leather shoes is simply to polish them frequently. Use a good liquid or paste shoe polish that has to be buffed to produce a shine. Work it thoroughly into all cracks and seams, and particularly into the space between the soles and uppers. An old toothbrush is good for this.

When two pieces of unlubricated leather rub against each other, they cause a squeaking noise. In shoes the trouble is usually between two layers of leather forming the soles. One remedy is to make a small opening at the edge of the layers and introduce through it a mixture of castor oil and powdered soapstone The opening is then closed by cementing or sewing

A leather article may often be given a new span of life by patching it. If the damage is a mere slit, sewing with linen thread may be all that is required. For a larger hole, a cemented patch that can be made almost invisible may be used. Cut a paper pattern to cover the spot; then lay out a patch about ¼" larger all around. It should be of the same kind of leather as the article being repaired. With a sharp knife, bevel the edges of the patch.

Lay the patch over the hole and dust around it with dressmaker's chalk or talcum powder. Remove the patch and, following the chalked outline, skive

A brief case is refinished with a leather dressing that will dye as well as polish

Tags of shoe leather are cemented down to prevent them from being torn off

Shoes may be waterproofed on uppers and soles. A commercial solution is used

If the leather at the lap joint of a belt loosens and rises, cement it immediately

Liquid dressing applied to the back of a belt soaks through to provide lubrication

around the hole, beveling the leather to match the patch. Use pyroxylin household cement, waterproof leather-belting cement, or a good rubber cement to fasten the patch in place. If a hairline shows around the edge, use ink of appropriate color to cover it. Finally, polish the area in the usual way. This technique may be used to repair the tiny cracks or slits that often appear in shoes where the leather bends in walking. Use slivers of leather of a size and shape to fill the crack, and apply ink or leather dye to color them before polishing.

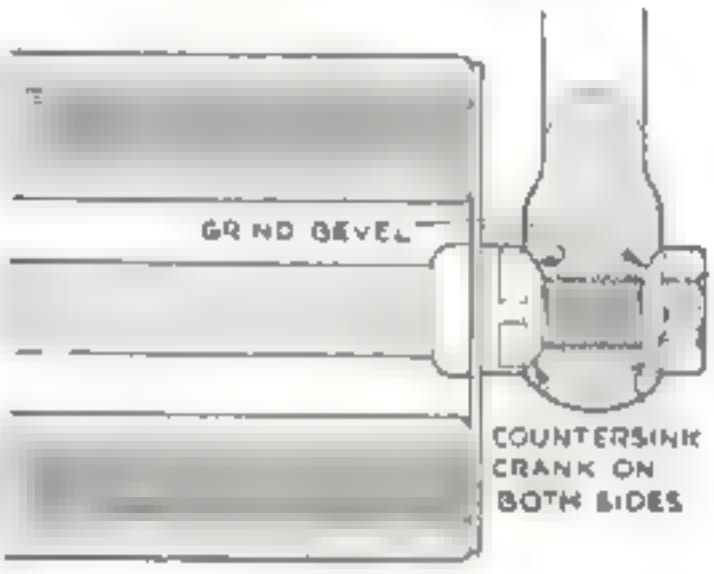
Many companies in war production have installed line shafts because of the scarcity of electric motors for individual drives. Since rubber belting is also hard to get, a good many leather belts are being used. The care of these leather belts differs according to their use and surroundings. In one plant, where lubricating oil gets on them frequently, they have to be taken down and cleaned often. The secret of good belt performance is proper lubrication to keep the leather soft and supple without making it slippery. A soft, pliable belt, combined with good pulley design and belt tension, requires no sticky, friction-producing dressing to make it efficient. Heat generated by pulley friction dries out a belt, so a lubricating dressing has to be applied each week or so.

Belt manufacturers can provide prepared dressings suitable for any variety of belt, but good lubricants can be prepared right in the shop. One consists of about equal parts of castor and neat's-foot oil. Like all such dressings, it should be applied to the outside of the belt and permitted to soak through to the pulley (hair) side of the leather. Another dressing sometimes recommended is a mixture of about 7 oz. of tallow and 3 oz. of cod-liver oil, by weight. Rub this on the pulley side of the belt.

When a belt slips because it has become coated with metal dust and oil, it should be dry-cleaned. Any well-equipped belting supply company can clean it, but sometimes the job can be done in the shop by washing the leather in a standard dry-cleaning fluid or in a gasoline-turpentine mixture (about twice as much gasoline as turpentine). After the belt is dry, apply a dressing.

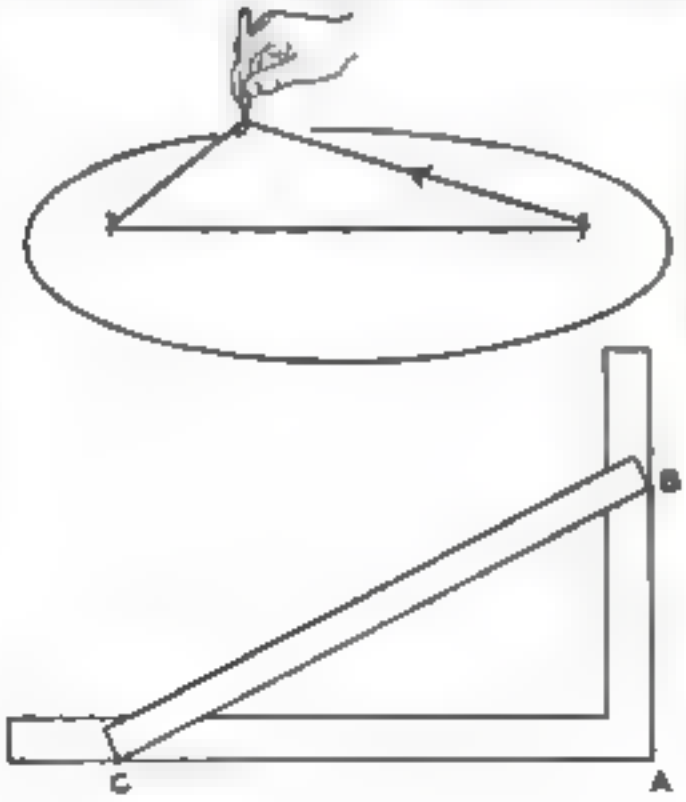
Mounting Stripped Bicycle Pedal

WHEN the threads of a bicycle pedal are stripped at the end, the pedal can still be made to serve by countersinking the crank on both sides, and beveling the pedal spindle on the grinding wheel, as shown in the drawing, so that good threads will project far enough through the crank for the nut to get a firm grip. Grind a bevel on the nut also, leaving about half of it untouched to provide a secure hold for the wrench employed to tighten it.—AXEL E. OGREN.



DRAWING ELLIPSES TO EXACT SIZE

[SHOP METHODS]



THE method of drawing a perfect ellipse with a pencil and a loop of string placed around two brads or thumbtacks, as shown in the diagram at the left, is frequently used in laying out work. An easy way to find the proper spacing between the brads and the correct length of string to be used is as follows:

Measure the breadth of the desired ellipse on one leg of a steel square, or any other right angle. This breadth is *AB* on the diagram. Now measure off the length of the ellipse from *B* to the intersection at the other leg of the square—*BC* on the diagram. The distance *AC* laid off on the leg of the square is the correct distance between the two brads. The sum of the distance *AC* and the length *BC* is the proper length of string in the loop.

POPULAR SCIENCE MONTHLY SHOP DATA

POPCORN CART

Holds Four Individual Servers

Cheer your guests with popcorn from a charming, hand-lettered wagon

By ELMA WALTNER

HOT buttered popcorn, that perfect snack for frosty evenings, will be welcomed even more enthusiastically, by children and grownups alike, if served in this attractive cart.

The four scoops, which are lifted out by handy finger holes, make convenient individual servers for guests.

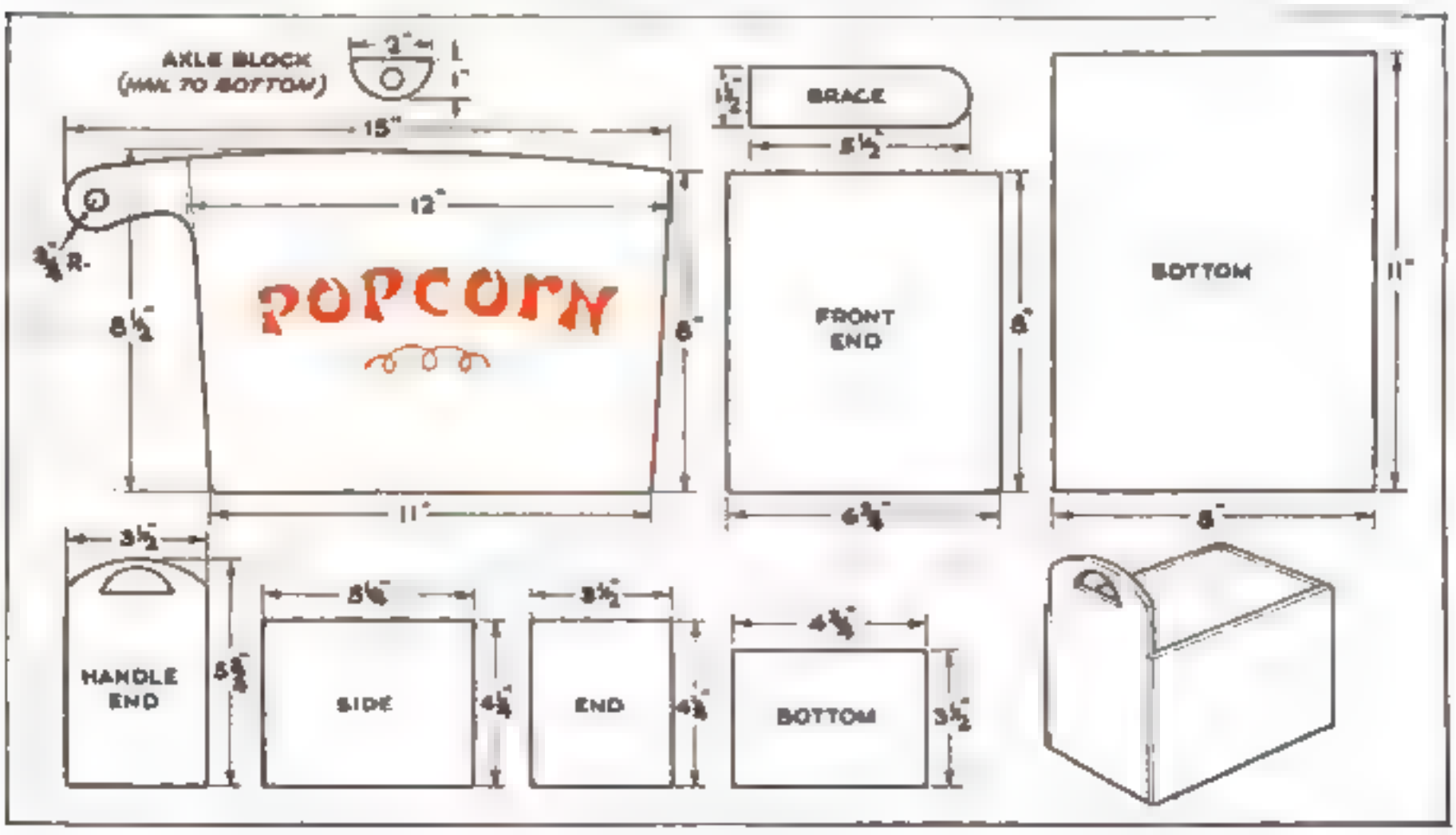
Make the cart of ¼" plywood, or, if this material is unavailable, of any well-seasoned ¼" stock. The sides of an apple box, if planed smooth, will do nicely.

The cart and the scoops are put together with ½" brads. Note that there is no back to the cart. This makes for easier removal of the popcorn boxes.

The axle blocks have holes slightly larger than the ¼" dowel axles, which pass through them and are glued into 4" plywood wheels. If desired, dummy wheels may be nailed directly to the body of the cart. Glue the handle into holes bored into the sides.

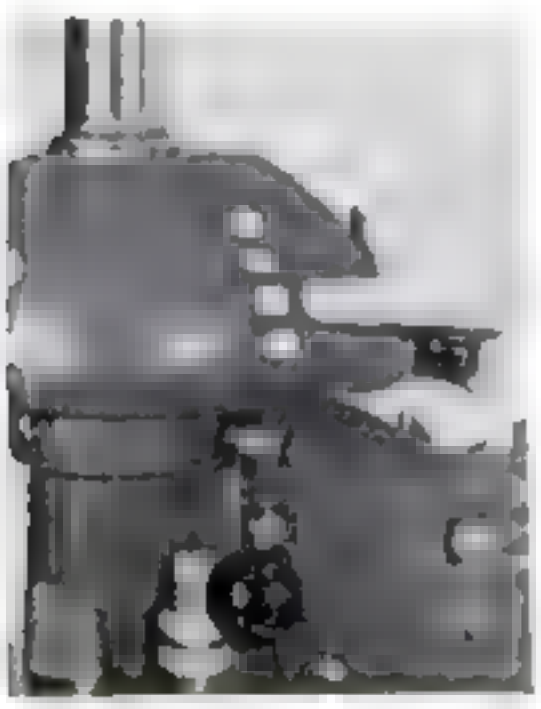
Finish both the cart and the scoops with two coats of clear shellac. The lettering on the sides of the cart is painted over the shellacked finish.

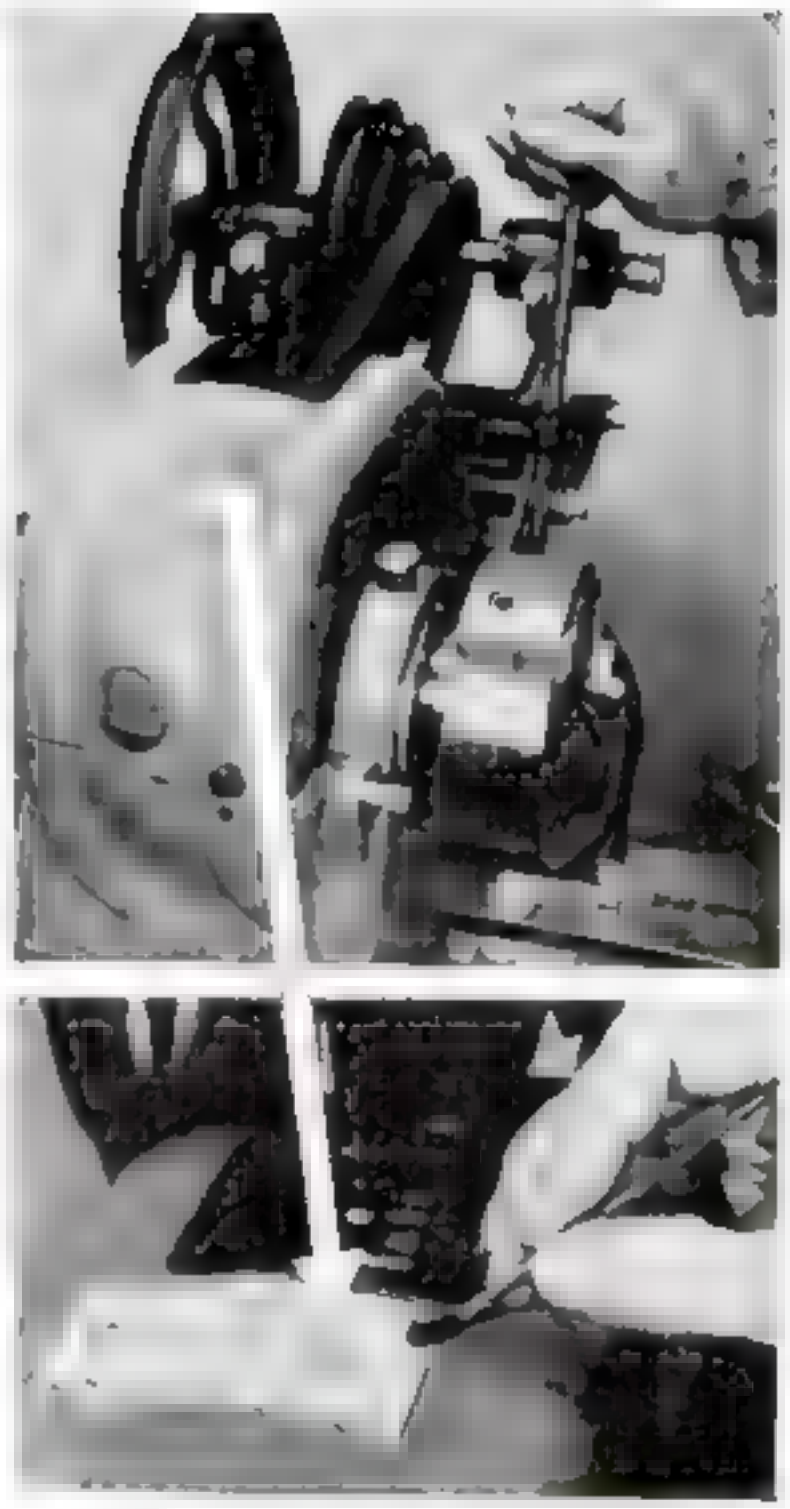
Wood stock, glue, brads and a little time are all you'll need to build this cart from the drawing below

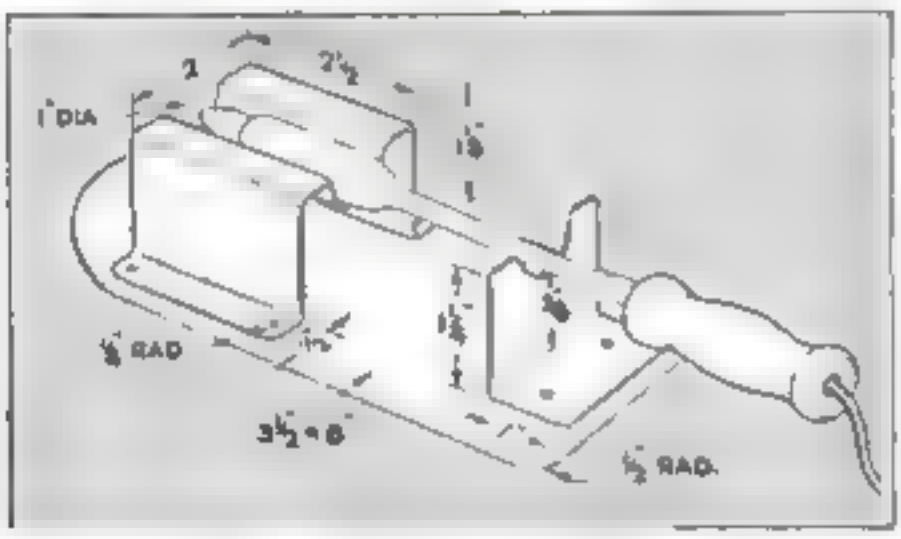


NEW SHOP IDEAS

QUICK-GLANCE SPEED CHARTS mounted on machine tools having step pulleys tell instantly how to obtain the nearest correct speed for working various materials, and do away with constant thumbing of the instruction book. The speeds obtainable on a drill press, for example, may be typed or lettered on paper and glued to the belt-guard, as in the photograph at left. On lathes, speeds for both motor and countershaft belt positions may be posted in the same way, together with detailed information on direct and back-gear drive, as shown at the right. Varnish, transparent cellulose tape, or wax will protect the paper and prevent it from being loosened.—R. HANSCOM.







A STAND to hold your electric soldering iron while it is still hot but not being used will protect your workbench top from the heat and prevent accidents. The parts for the one shown in the drawing were cut out of 23-gauge sheet metal, although tin-can material may be used if no other is available. Bend the supports to shape in a vise, forming the rounded portion by hand or over a pipe. Holes are drilled for screws in the places indicated, and the holder may be fastened to a wooden block or permanently mounted on the workbench by means of these screws joining the parts. The sheet-metal base shown is optional.—M. ROSENFELD.

BURNED-OUT HEATING ELEMENTS can be repaired efficiently with powdered iron cement of the type sold at most hardware stores. Raise each end of the parted resistance coil, clean the first two or three loops with sandpaper, and interlock them. Do not join more than two or three loops of each end because this might reduce the resistance too much and cause the coil to burn out again. Mix a little iron cement with water, and apply the paste to the interlocked loops, filling and covering them, and smoothing down the top surface below the groove in the insulation. Let the cement, which is a fairly good conductor, set thoroughly before turning on the current.—W. C. WILHITE.

HOLES IN WELDING-TORCH TIPS or in the generators of gasoline blowtorches can be cleaned with steel bristles cut or pulled from a rotary scratch brush of fine or medium grade. Bristles of either of these sizes are fine enough to go through the holes without enlarging them. It will not impair the efficiency of a good wheel to have a few bristles cut from it, if an old wheel is not available at the time a cleaning wire is needed.—W. C. W.

MACHINISTS FOR WAR WORK

1 "Here is that gear-blank job for you to start on, Ray," says the foreman as he hands the rough stock to the machinist. "As you see, it's already centered . . .

Turning Work of

From the U. S. Office of Education Training Film, "Turning Work of Two Diameters"

Whether you're preparing for defense work or already in it, your advancement will depend on what you know. "Learn more to earn more" is a good slogan these busy days. To train war workers in the fundamentals of machine-shop practice, the U. S. Office of Education has prepared a series of 16-mm. sound films, one of which provided the material for the following article. These motion pictures, distributed for the Government by Castle Films, are of inestimable value to the shop student and beginner. Don't fail to see them if they are being shown in your community or at the plant where you are employed.

ALL the power that drives America's mighty war machines is transmitted through wheels of steel. These must be carefully designed and skillfully machined. In making the spur gear and shaft of a U. S. Army "blitz buggy," for example, time is saved and strength and precision are gained when both the shaft and gear are turned from a single piece of steel, eliminating the use of fragile pins, keys, or splines, such as would be required to lock the gear on the shaft if the two parts were produced separately.

The blank for this unit must be turned on an engine lathe, after which the teeth can be cut by a milling machine. A piece of rough stock in the capable hands of the lathe operator and a drawing from the shop foreman's desk are all that is needed for the making of the blank. The lathe job requires

2 "Let's look at the drawing together," he goes on. "Notice that the collar diameter is 2¼", and that it is ⅜" wide, with tolerances as shown . . .

3 "On the finished piece, both shafts are 1" in diameter and 4" long on each side. Be sure to finish up fillets where the collar joins the shaft."

4 Roy first measures the stock to make sure it is big enough. Then he studies the drawing, notes diameter tolerances, and decides the order of cuts

5 Using the right size of lathe dog is important. Roy picks one to fit the work closely, clamping it to one end of the stock with the tail facing out

Two Diameters

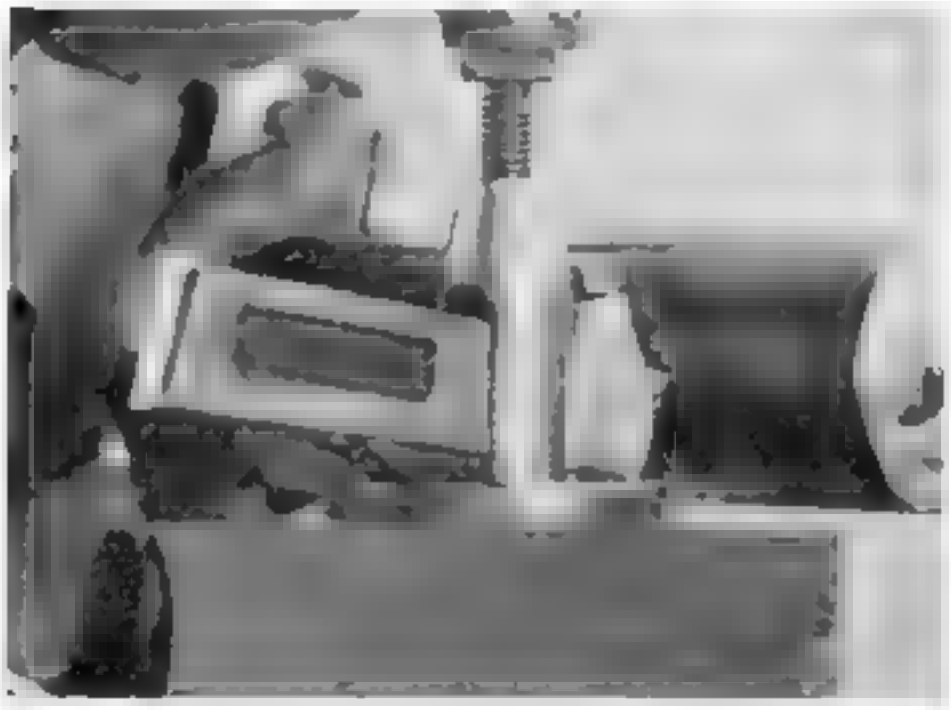
turning a piece of two diameters, and the collar that will later become the gear must be of a specified width and diameter and should be finished with fillets where it joins the shaft. The accompanying series of photographs shows step by step how the blank is turned.

The rough stock is a piece of machine steel, 2½" in diameter and 9" long, already centerdrilled. The foreman gives it to the operator and turns over a print of the drawing to him, pointing out the more important features of the work. As always, the machinist's first job is to study the drawing and determine the order of the cuts. Then he places the drawing on a blueprint board where he may refer to it conveniently, cleans and oils his lathe, sees that his tool rack is in order, and clears the floor of obstructions. As an efficient operator, he is dressed with due regard for his personal safety, with collar buttoned, sleeves rolled high, necktie tucked into his shirt, and hair combed neatly and in place.

The machinist measures the stock, noting that the collar diameter must be brought down to 2¼" and the shaft diameter to 1", with tolerances of .004" on the collar and .002" on the shaft. The collar width is ⅜", the shafts are 4" long from each collar face, and the piece is 8¾" long over all. He then selects a dog to fit the work—one neither too large nor too small—making certain that its tail is pointing to the headstock. He cleans the center holes, and lubricates the one to go on the tailstock center. Then the work is mounted in the lathe, and the tailstock spindle wheel is adjusted so that the piece turns freely but not loosely between centers.

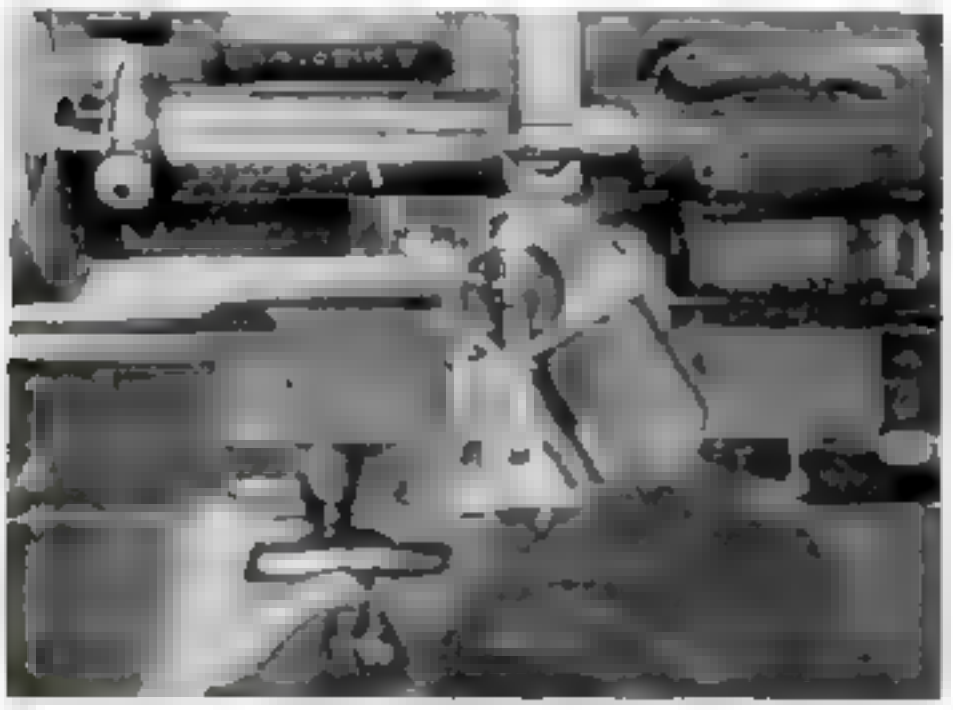
Since the stock is rough, a truing-up cut must first be taken. The tool required for this must be sharp and properly ground so that it will remove stock rapidly. After a short trial cut is made, the piece is calipered and found to be 2½" in diameter. Now the

6 After carefully lubricating the center at the tailstock end, he mounts the stock between centers and brings the tailstock center up. The dog tail is in the slot of the faceplate, and the work should turn freely



7 A correctly ground roughing tool, used to make the first cut, is adjusted in the tool post, with the cutting point set just above the center of the stock. For safe turning, there must be a minimum of overhang

8 The tool post is turned to bring the tool bit at a right angle to the center line of the work, which is revolved slowly by hand to make sure that all is clear. With speeds correctly set, Roy makes a short trial cut



operator's problem is to bring the work down to the required 2¼" diameter of the collar, which is the largest part, plus about 1/32" allowance all around for the finishing cut to be made later. This may be accomplished by setting the depth of the rough cut at 3/32", or .093", thus reducing the total diameter by 3/16". This cut is made as near to the revolving dog as possible, but always out of danger of actual contact. Care must be taken to keep the tail center well lubricated and properly adjusted during the cut to keep the work from expanding and binding between centers as it becomes hot.

To obtain a reference point for the width of the collar and the length of the two parts of the shaft, one end of the work is next faced off. A rule is then used to measure from this end, and the tool is set for turning a nick or groove that marks one face of the collar. Several roughing cuts follow to bring the shaft down to rough size, leaving 1/32" for the finishing cut. Then the face of the collar is turned, leaving the same margin for finishing, as well as a 1/16" shoulder for the fillet.

A preliminary finishing cut can be made with the roughing tool to within .010" of the final size. Then a finishing tool is used to take a cut of .005" (remember that twice the depth of the cut is removed from the diameter of the work). For facing the collar—the operation that brings this end of the shaft to finished length—a radius tool is used. Only the fillet remains to be done on this end.

The work is now reversed between centers. Exactly the same operations follow as were used in turning the other end. Then, after a finishing tool has brought the shaft and the collar to their correct diameters, the collar is faced to the required width, again leaving only the fillet allowance. Afterwards the end of the shaft is faced with a finishing cut to the exact length specified in the drawing, the steel rule being used to measure from the finished face of the collar.

Finally the fillets, which add strength to the shaft where it joins the collar, are turned with a radius tool, which is set on center and used first on one side of the collar, then on the other. This completes the machining of the piece, and it is then checked against the drawing for possible errors.

When inspection is completed, the blank is ready to go to the milling machine to have the gear teeth cut.

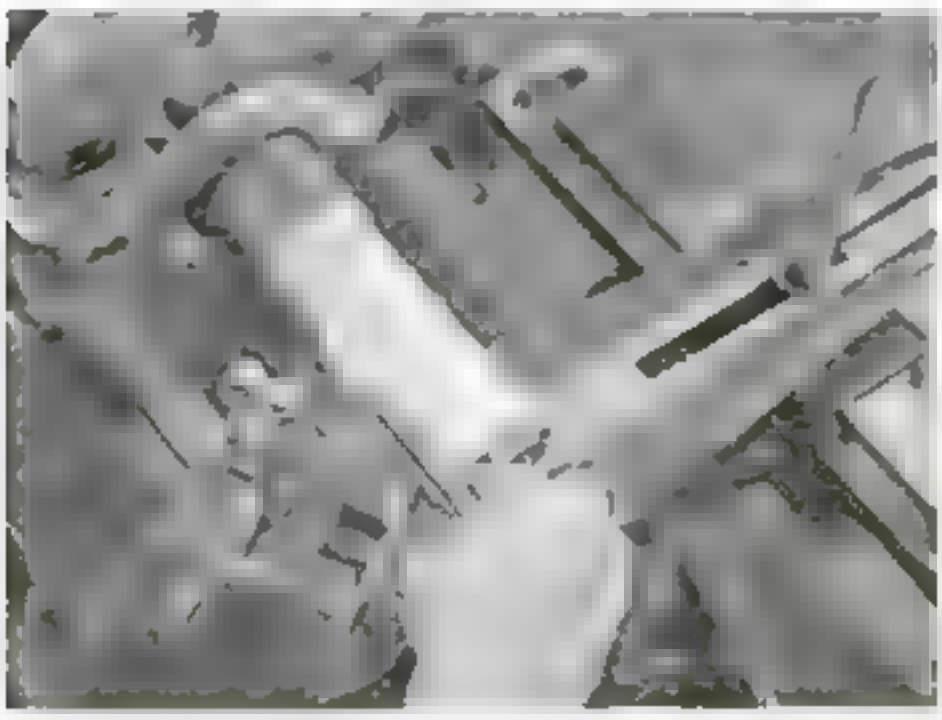
9 The cut is stopped after it has proceeded about ¼". The diameter is calipered and found to be 2½". The finished size is to be 2¼", but 1/16" more (1/32" all around) must be left for the finish cuts

10 Since the tool is set in only one half as much as the amount of stock to be removed, Roy will adjust the feed and speed for a rough cut of 3/32", or .093", which will remove 3/16" from the diameter

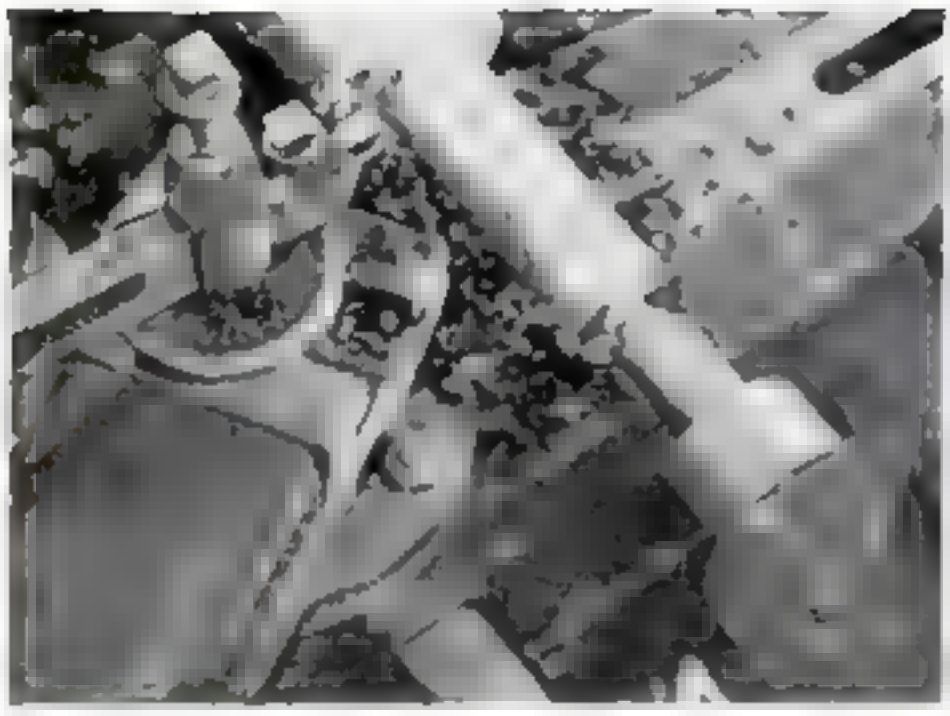
11 The new cut is checked with calipers, and, if correct, is continued up to a safe point from the whirling dog. Care should be taken to keep the tail center oiled, and set neither tight nor loose

12 Before accurate measurements of length can be made, the end must be faced off as a point of reference. For this, a facing tool is used, set so that the cutting edge is turned in toward the work

13 The drawing shows the shaft to be 4" long. Roy measures this from the end just faced and sets the tool exactly at the end of the rule. He starts the machine up to cut a groove at the desired point

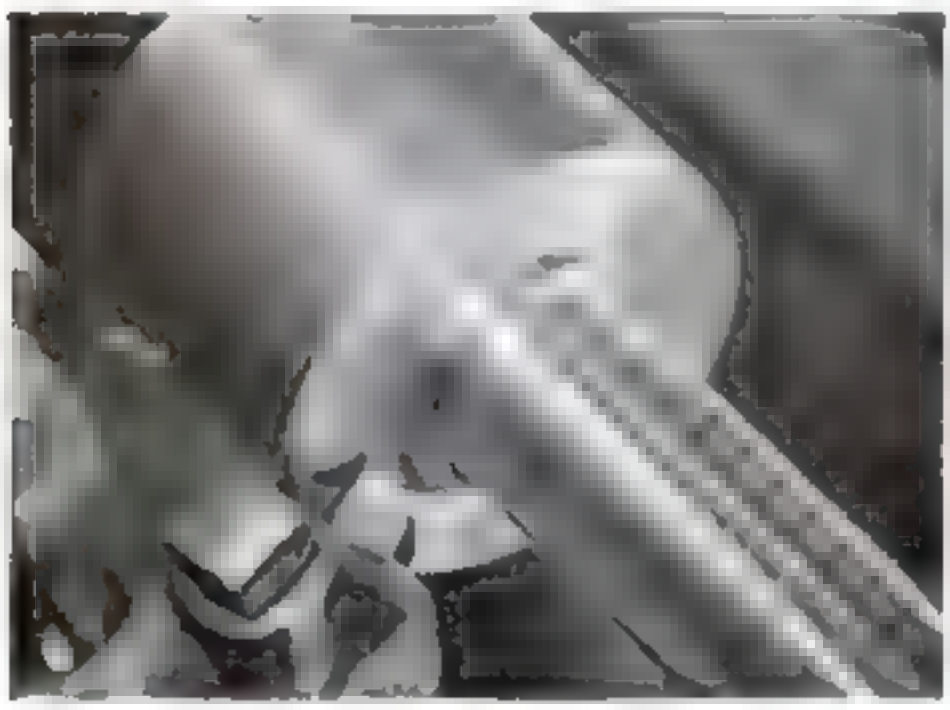


14 This groove marks the face of the collar, but some excess will have to be left on this face for finishing, so the rough cuts that are to follow will be made only to the right of the groove's edge



15 The shaft is to be 1" in diameter, plus .002" tolerance. Roy makes rough cuts to begin the process of bringing it down. The last one must leave 1/32" all around for the finishing cut made later on

16 After this final roughing cut is started, it is checked with a micrometer to make sure that it is not too deep. If it is satisfactory, this cut is extended all along the shaft to the marking groove

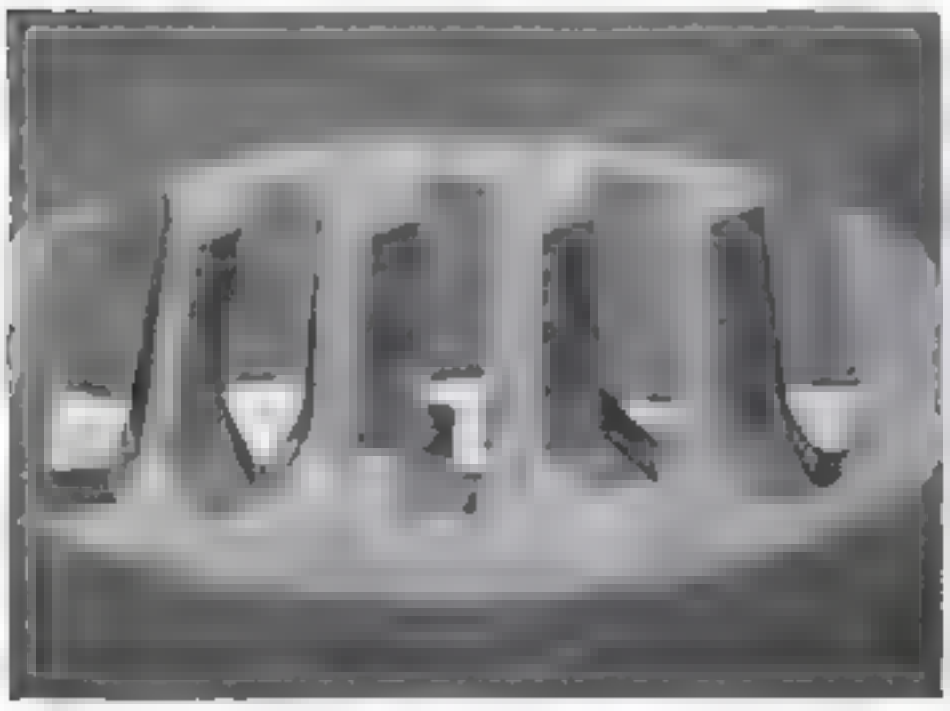


17 The face of the collar is still uneven and has to be machined. The same roughing tool is fed in by hand against the face of the collar. Note the stock left for the 1/16" fillet to be turned later

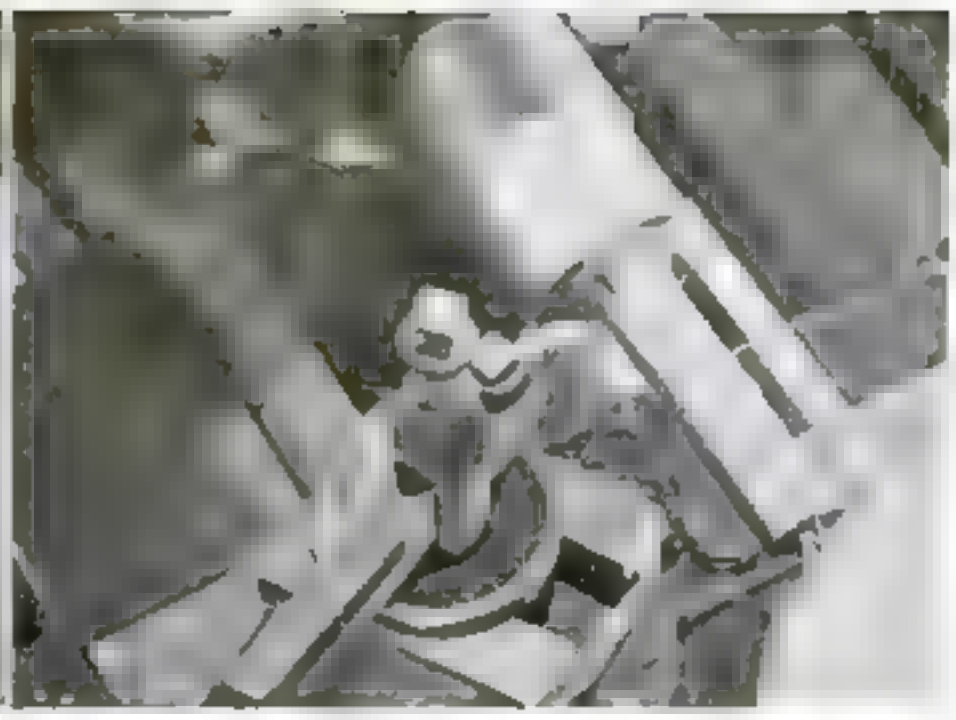
18 Roy is now ready for the finishing cuts. The first one can be made with the roughing tool to within .010" of final size. After starting the cut, he again carefully checks with a micrometer

19 A finishing tool is now needed for the final cuts to the tolerances specified. Here below, from left to right, are bits ground for roughing, finishing, parting, threading, and radius forming

20 On this finishing tool the nose is flat and narrow, while the end relief angle, or heel clearance, is about 10 degrees. Note particularly the lip which gives the tool a fine cutting edge



21 As seen from the cutting edge, arrows show the sides of the tool without any side rake or relief angle. The nose must be set parallel to the work and on dead center, while the cut is .005"



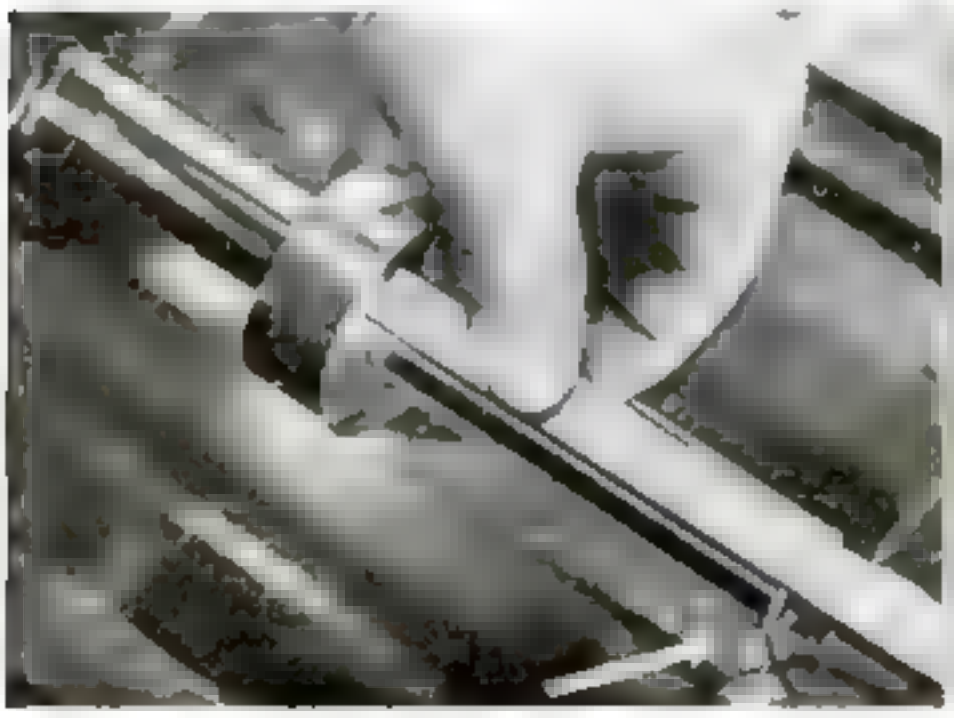
22 A radius tool, set at a convenient angle, is used to face the collar. Measuring the length of the shaft from its trued end with a steel rule, Roy sets the tool against the collar by hand feed

23 The piece is taken out, and a smaller dog is clamped to the finished end with a thin band of soft metal to prevent surface marks. The work is remounted, and the other shaft end rough-turned

24 Finishing cuts bring the shaft and collar to correct diameter. Roy measures the width of the collar, and with a rough facing cut and a light finish cut brings it to size, plus fillet allowance

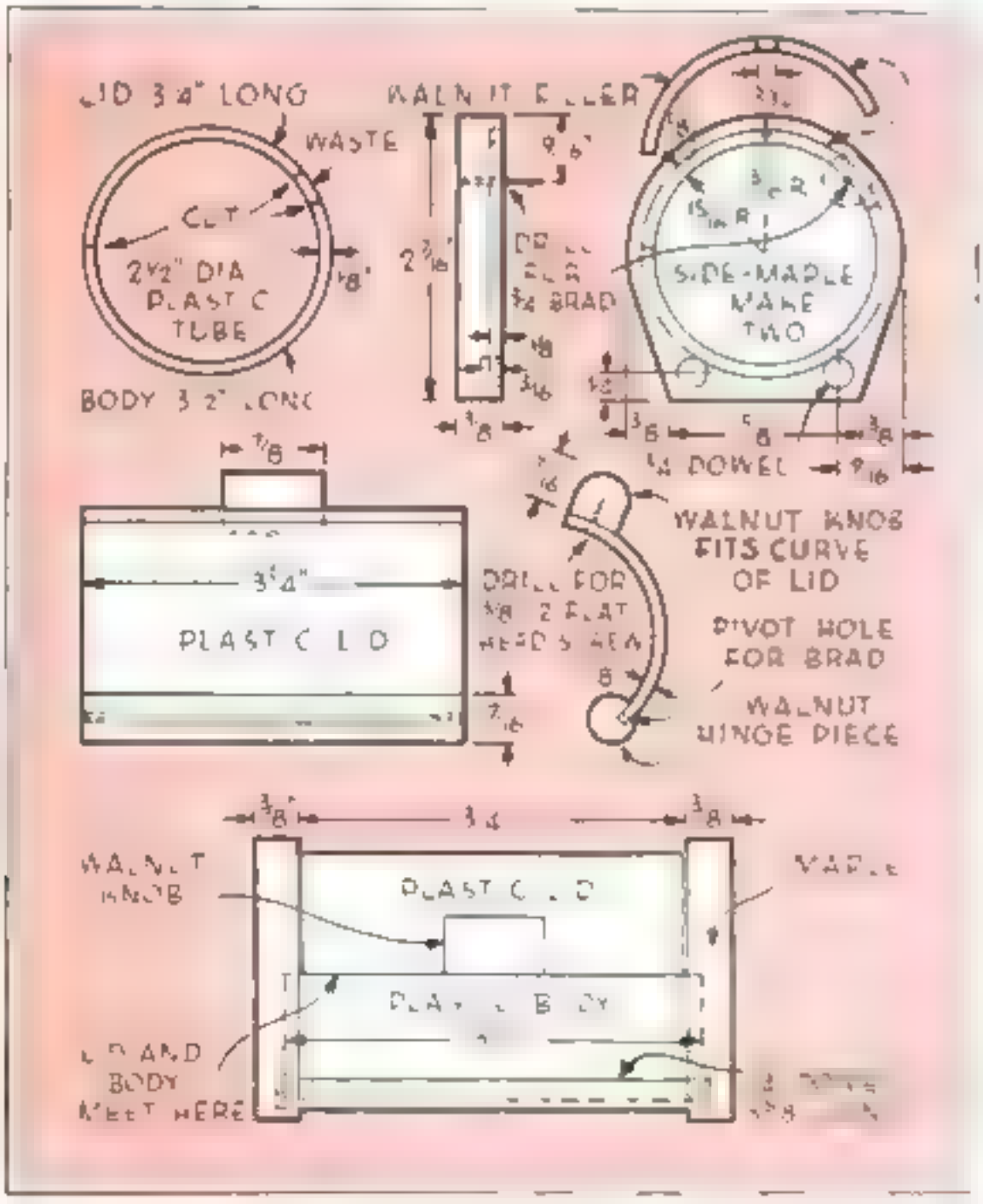
25 The other end of the shaft is measured from the finished face of the collar, and is now being machined to its exact length. Arrow shows the facing tool making the cuts at the end of the shaft

26 A radius tool is used to turn the fillets. The carriage feed is operated with the left hand, the cross-slide feed with the right. Finally, the work is once more checked against the drawing



WORKING TIME: TWO EVENINGS

Made from clear plastic, maple, and walnut, this cigarette box is a handsome project involving several interesting operations

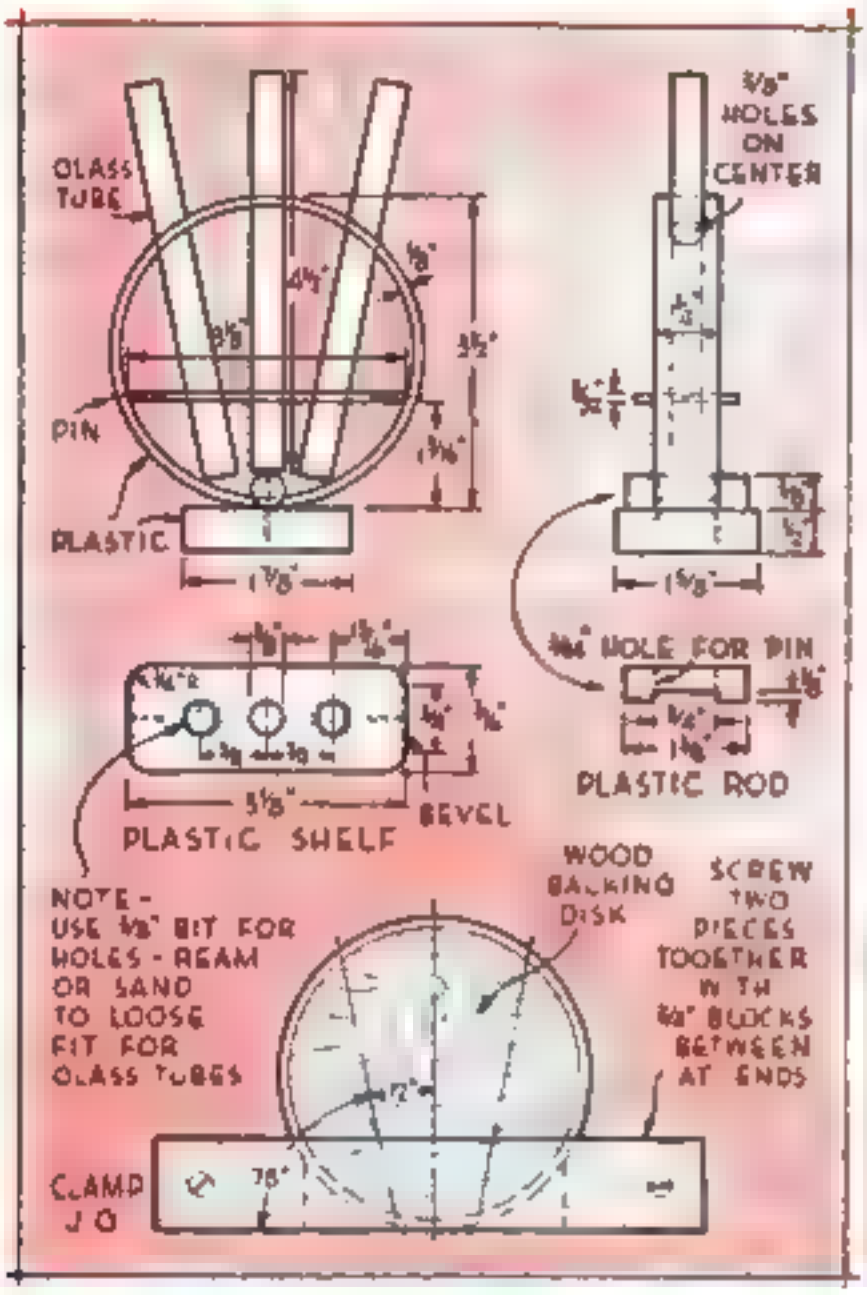


Many craftsmen have scraps of plastic left over from completed work. Here are three projects that can be made from such odds and ends. None calls for a piece longer than 4", yet all show off the beauty of this material to the full.

CIGARETTE BOX. Clear plastic, maple, and walnut are combined in this unique occasional piece, displaying both the plastic and the woods to good advantage. A clear-plastic tube 2⅛" in diameter and 3½" long is sawed apart as shown in the drawings at the left to form both the body and the lid. Lay out two maple endpieces, as shown, on ⅜" stock. Drill two ⅛" holes 3/16" deep in each for the dowel rails, which are also of maple; then cut out the ⅛" by ⅛" circular groove with a circle cutter, and finally cut and sand the outside to shape. Use the circle cutter also to cut a ⅛" by ⅛" walnut ring, from which filler pieces can be made to close those portions of the grooves alongside the lid.

Cut the lid to 3¼" in length, saw off a strip ⅜" wide along

By
ERNEST R. DEWALT



one side, press the lid into a 3/16" deep groove in the walnut hinge piece, and attach a walnut knob with a small countersunk screw.

Assemble the ends, body, and dowel rails with cellulose or model-airplane cement. Fit the lid in place, and drill through the maple ends into the plastic—not the hinge piece—for pivot pins. Insert these, and fill the holes over them. Finish with three coats of wax applied to the wooden parts, rubbing well after each of the coats. Working time: 4½ hours.

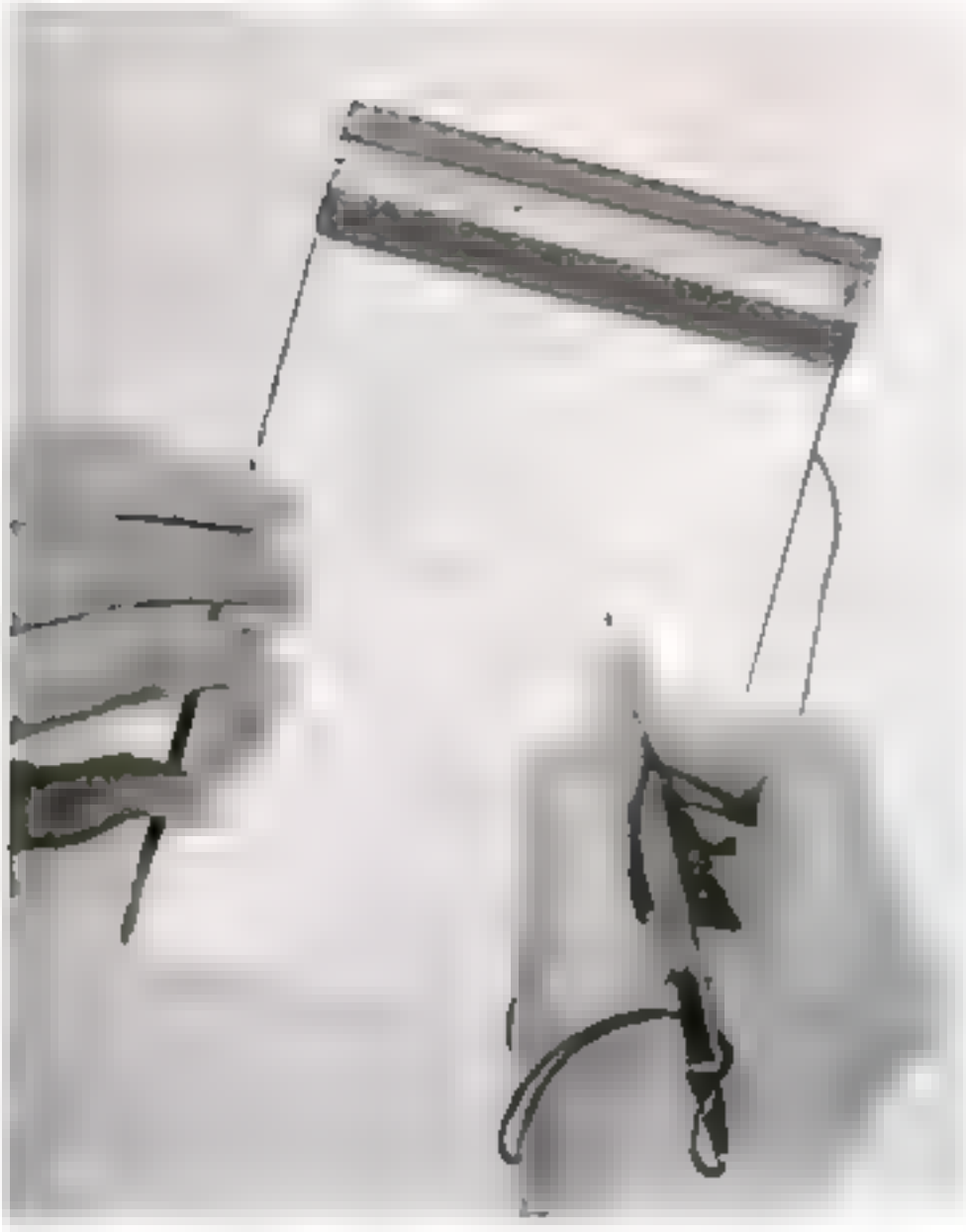
THREE-BUD VASE. This triple flower holder provides a decorative touch on the table, mantel, or piano. Clear-plastic pieces are used. The dimensions given in the drawings may be altered to suit the material on hand. For the holder shown, a ⅜" wide band, or ring, cut from 3½" diameter tubing was used, and three holes were drilled in it to support the vases, which can be small test tubes or vials.

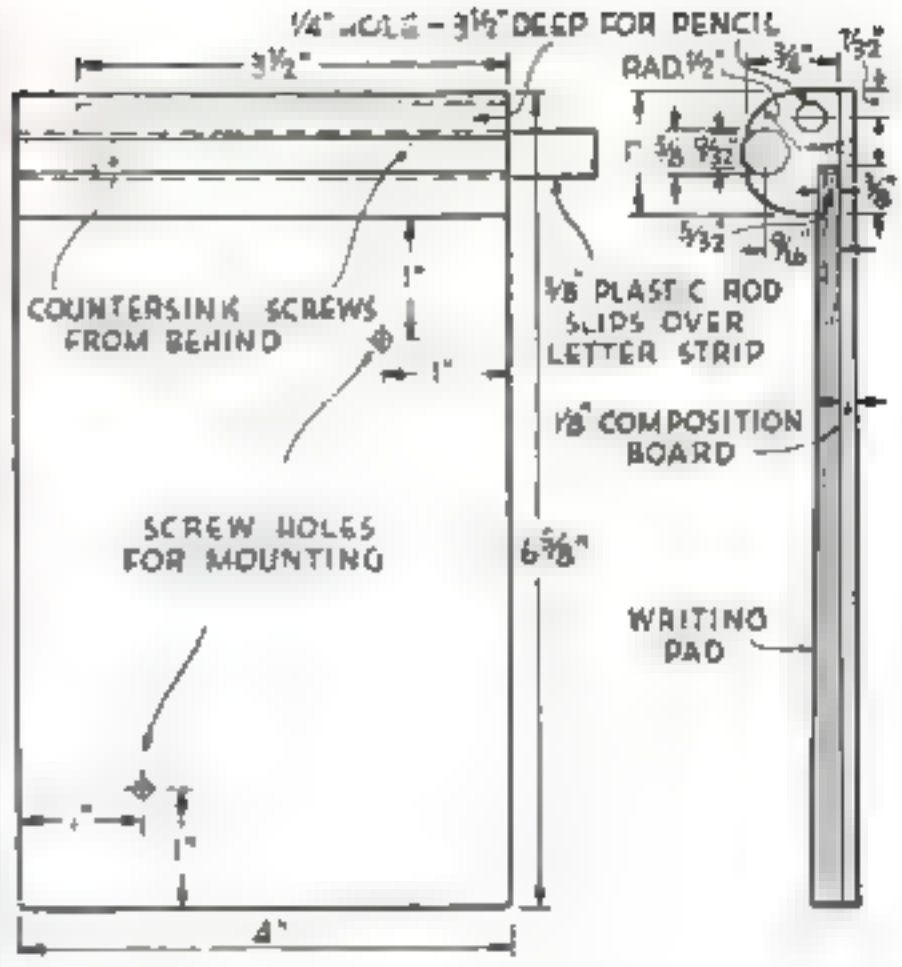
A simple drilling jig will prevent breaking of the edges of the holes. Band-saw a wooden disk to a snug fit inside the ring. Mark the middle hole, and with a flexible rule or a piece of paper bent to the contour of the tubing, lay off two other holes 1⅛" to either side. Secure the work with the backing disk in a clamping jig as shown. Drill the holes with a ⅜" bit, tilting the drill-press table 12 deg. for the two side holes.

Note that the shelf length is less than the ring diameter. Round the corners, and bevel the short edges to fit inside the ring. Ream or sandpaper the holes to a free fit for the vases. Line up the holes by a trial fit; then drill a slightly undersized hole through each side of the ring into the shelf and press in a ½" escutcheon pin.

The ring is held on a base by a ⅜" plastic rod 1⅝" long, in which a ⅛" by ¾" notch is cut. Drill both the rod and the base for escutcheon pins, file small notches in the ring where these pass, and assemble.

Sand all edges very smooth, and buff any scratches off the polished surfaces. The





edges may be left unbuffed for textural contrast. Working time: 4½ hours.

MEMO PAD. This is handy for kitchen reminders, an office desk, or messages from callers. The over-all size, 4" by 6⅜", fits a 4" by 6" stock pad slipped into a 5/32" by ⅜" rabbet in the molded hardwood strip. Use a 1" by 1" by 4" piece of walnut, mahogany, or maple. Drill the ⅜" hole through with a keen spur bit. Use fine sandpaper on a dowel to sand the hole so that a ¼" wide strip of paper and a ⅜" clear plastic rod may be inserted together. Open out the hole with two saw cuts 9/32" apart, and then round off the outside to ⅛" radius. Drill a ¼" blind hole in from one end to a depth of 3½" for a pencil, which may be secured with string or fine chain. Screw the strip fast to a ⅛" composition-board back. Finish with two coats of clear lacquer, but apply none to the channel. Insert a typewritten strip and the plastic rod, which will magnify the lettering. Working time: 3½ hours.

PLATING NONMETALLIC WORK [ELECTRICAL]

Tnx plating of nonmetallic articles is generally thought of in connection with baby shoes, but other objects that can be encased in electroplated metal include flowers and insects, leaves and fruit, plaster casts, pottery, textiles, wooden handles, buttons, drinking cups, and so forth. A small wooden box or drawer pull can be more uniformly covered with metal by electroplating than by working metal in sheet form.

It is necessary first to treat the surface of the work so that it will conduct electricity. A rough method consists in coating the surface with spar varnish, then, when this is tacky, laying pieces of thin metal foil on it much as sign painters apply gold leaf. It must be patted into close contact if detail of the work is to be reproduced.

A better way of forming the conducting surface is to give the work a thin coat of wax (paraffin) or electrotypers' varnish. These must not be applied so heavily as to obliterate detail. The conductive powder generally consists of finely powdered graphite (known as plumbago or black lead) as used by electrotypers. Copper bronzing powder is also used carefully applied, it allows faster plating. All grease must be removed from the powder by shaking it in a bottle with acetone.

The conductive powder is applied with a soft brush. Particular pains must be taken to see that all crevices are coated. Brush off the surplus after the work has taken on a shiny thoroughly coated appearance. The cathode connection is best made by slinging the work in fine copper wires. Rinse it well in water before transferring it to an acid copper plating bath. After the article has been plated with copper, it may be plated with some other metal if desired.

POPULAR SCIENCE MONTHLY SHOP DATA

ADJUSTING THE CUT-OFF TOOL is generally considered one of the most difficult of lathe operations. The tool must be ground properly and adjusted to exact lathe center height. At the left is shown a quick and accurate way of doing this. A machinist's rule is used to measure up from the ways to exactly the height of either center, and the tool is set at precisely that height.—C. W. W.

NEW CUTTING OILS adapted to specific machine operations now eliminate in large part older trial-and-error methods of prescribing proper grades. They permit faster speeds and new methods of tooling, closer tolerances, and increased use of alloy steels with lower machinability ratings than metals normally used. The oils are higher in active sulphur than ordinary types and reduce the tendency of ferrous metal surfaces to fuse or weld, thus eliminating any bonding of the tool and the surface being cut.

Another step toward production efficiency is a newly perfected graphite lubricant for the dead centers of lathes. This is a compound of flake lubricating graphite and specially formulated ingredients which effectively controls overheating and protects dead centers against scoring and softening

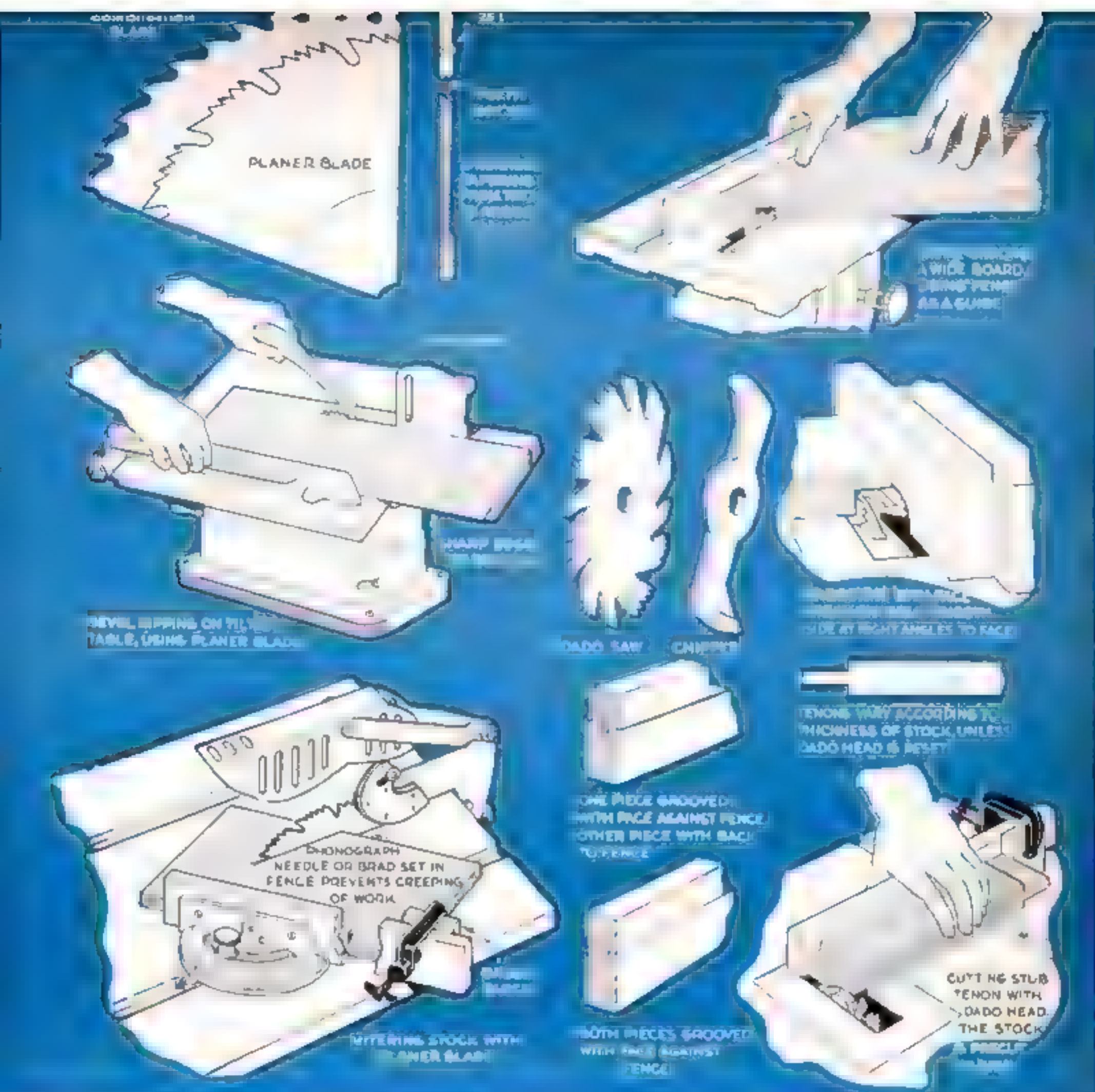
GROTESQUE WELDING MASKS. Fighting planes painted to resemble sharks may have inspired these welders at North American Aviation to apply war paint to their helmets—or perhaps it's an old Indian custom they've adopted to scare the Axis. Other workers have followed suit, and many weirdly decorated masks glower from the walls of the plant's locker rooms.

EDWIN M LOVE

Using Special Blades on the Circular Saw

SPECIAL accessories and jigs greatly increase the usefulness of the circular saw. Often they enable it to double for machines that may be lacking in the home workshop. Many useful attachments can be made of wood in the shop. Others must be purchased, and among the most important of these are planer saws and dado heads.

What is a planer saw? This is a stiff combination blade having groups of crosscut teeth alternating with single ripping teeth called rakers. It has no set; clearance is obtained by hollow grinding, which decreases the thickness of the blade from the teeth to the arbor washer. It is designed only for fine work. If kept sharp and



properly jointed, so that it is at all times perfectly round, it cuts with almost glossy smoothness, but when dull it can hardly be made to rip, and will usually wander off along the grain of the wood.

For what is a planer blade used? Its smooth cut makes it especially useful for ripping glue joints. Use only material that is reasonably straight, for wind (twist) will bind the blade, and the cut will not fit the joining member. The edge bearing against the fence must not be irregular, or the cut will be unsatisfactory. When the edge is to be beveled, as in ripping a side for a column, tilt the table to the correct angle and adjust the fence so that the far edge of the board slides against it. This enables the fence to carry the sliding thrust of the piece, and prevents pinching of the saw. If the piece is too wide for this, place the fence above the saw, so that the weight of the work below the blade will tend to open the kerf. On saws having tilting arbors, the tendency to slide is not present.

When several pieces are to be ripped to the same width, bevel one edge of each; then bevel the other edges after adjusting the fence to the desired width. Always slide the board along with the sharp edge up, for if this edge lies on the table it will wedge under the fence

For a three-sided column, the bevel must

Dadoing a wide board to receive a shelf, with an auxiliary fence on the miter gauge. The ripping fence could also be used

face to the fence, with the upper edge high enough to clear such obstructions. It is necessary to rip the piece to width before beveling the second edge.

How is the planer saw used for crosscutting and mitering? Just like an ordinary blade, except that the feed must be slower. If there is objectionable splintering of the underside, make a wooden insert to replace the soft-metal one furnished with the saw, and slit it to fit the blade by lowering the table (or raising the arbor) as the machine runs. This insert will support the work up to the very edge of the cut.

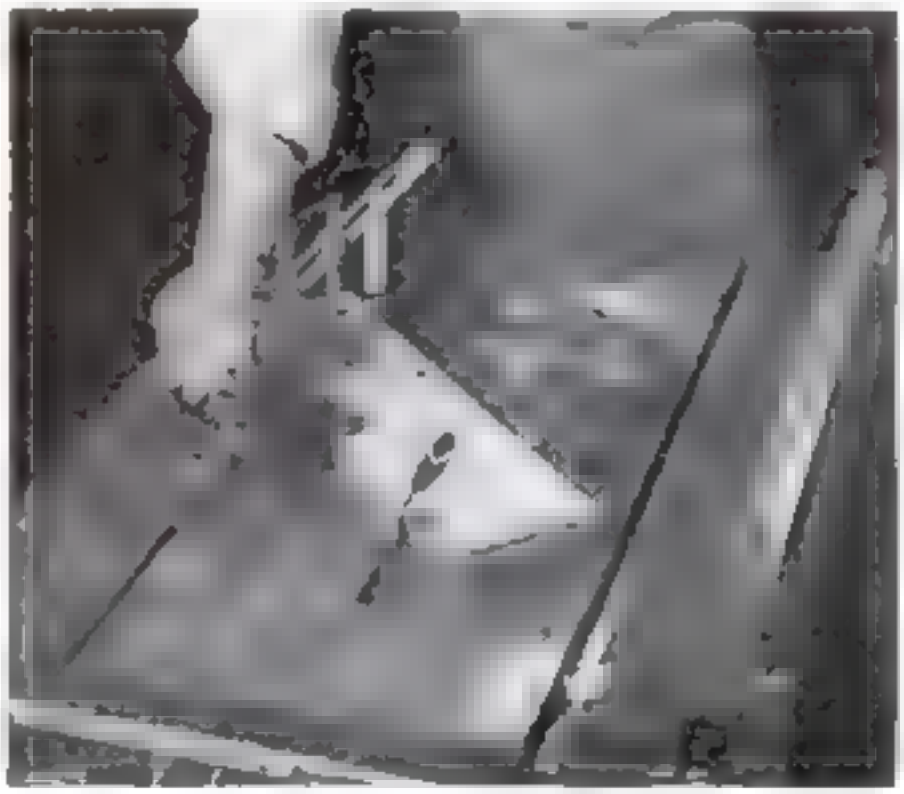
Can the parts of a dado head be used separately? Yes. To cut a groove ⅛" wide, use one saw of the combination; for a width of ¼", use both. Wider grooves are cut with chippers between the saws, arranged with the swaged edges opposite the openings between the teeth, and fanned out so as not to interfere with each other.

How is a dado head used? It must be accurately set for depth, and then used as if it were a thick blade. When grooving lengthwise of stock, set the fence as for ripping, measuring from the side teeth and making test cuts in scrap wood. Any ordinary groove is made in one pass, but dadoes wider than the head are cut in two or more passes with the fence reset or a strip of wood laid between it and the work to locate the second side.

be ripped with the stock edgewise on the table. After the cut has proceeded a little distance, the board tends to settle, which may damage the sharp edge and spoil the straightness of the work. This can be prevented by clamping or tacking a strip of wood to the back so that this strip rides on top of the fence, as shown in the photograph on page HW 32. If bolts or other projections interfere, attach an auxiliary wooden

Have the face side of each piece bear against the fence when grooving stiles and rails for a panel. All grooves will then meet in perfect alignment

Use of a clamping device when mitering prevents creeping. The reversed gauge allows full contact between the edge of the stock and the gauge head



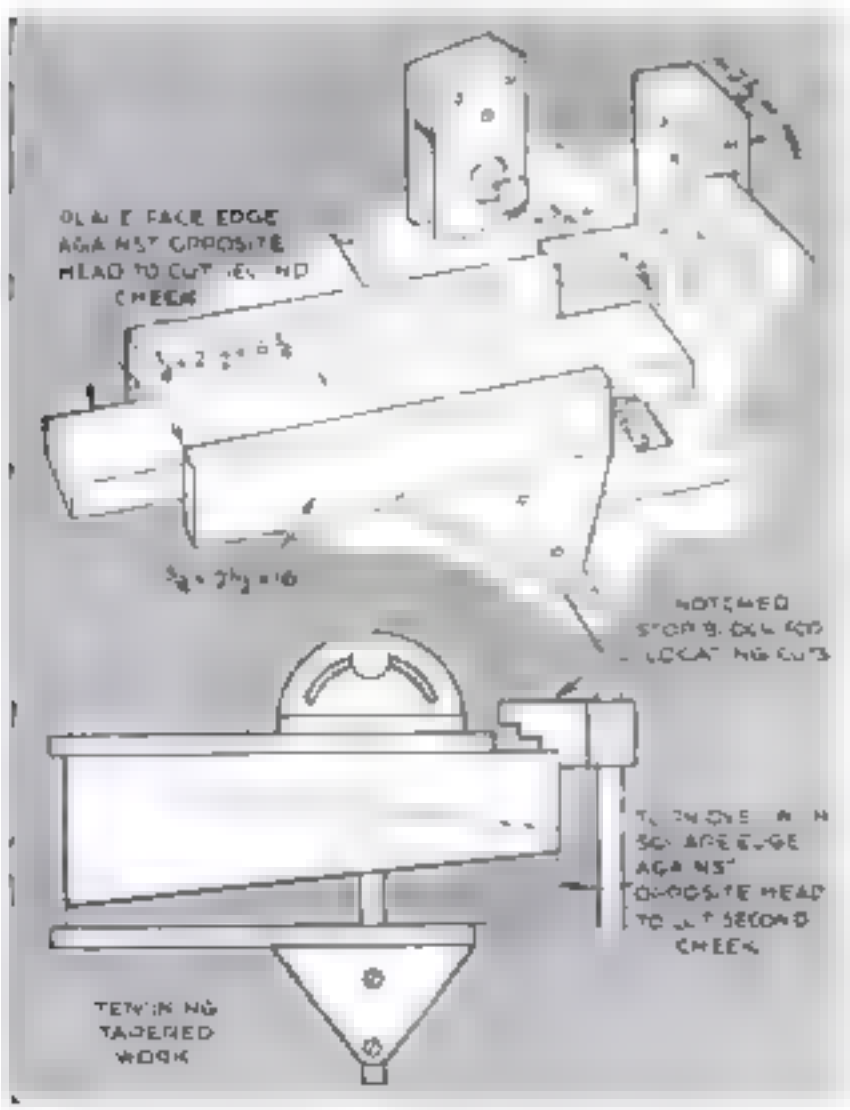
When grooving edges for a panel, as in stiles or rails, slide the face side of each against the fence so that the grooves in all pieces will be the same distance from the face. The same applies to cutting spline grooves, as shown in the drawings. If the material is bent, try to spring it flat against the fence.

Grooves across the grain on wide boards can be made with the end of the stock sliding against the fence. On narrower work, however, the miter gauge is used.

In making tenons, use the miter gauge and cut a dado along what is to be the shoulder. Shift the piece and make a second cut beside it, and so on to the end. Then turn the miter gauge end for end to cut the other cheek. This keeps the face edge against the gauge head in cutting both tenons. The stock should be precut to exact length, and the tenon length located with a block clamped to the saw table. This method permits tenons of any length to be made. A disadvantage is that the tenon thickness varies according to the thickness of the stock, unless the depth of cut is changed.

How are rabbets cut with a dado head? Rabbeting is done much like grooving, but with one side of the dado head exposed. When the fence is used on long cuts, set it away from the saw a distance equal to the thickness of the flange to be left on the edge, set the head for depth of cut, and pass the work over edgewise. This results in a smooth side parallel to the face. For a smooth side at right angles to the face, lay the stock flat on the table, with the edge against the fence. If the fence is arched, or an arched auxiliary wooden fence is used, the lumber can be rabbeted edgewise with the flange outside, the unused portion of the dado head running without obstruction under the arch of the fence.

When beveling a second side, as with the tilting-arbor saw above, keep the sharp edge of the finished bevel up, or it may wedge under the fence

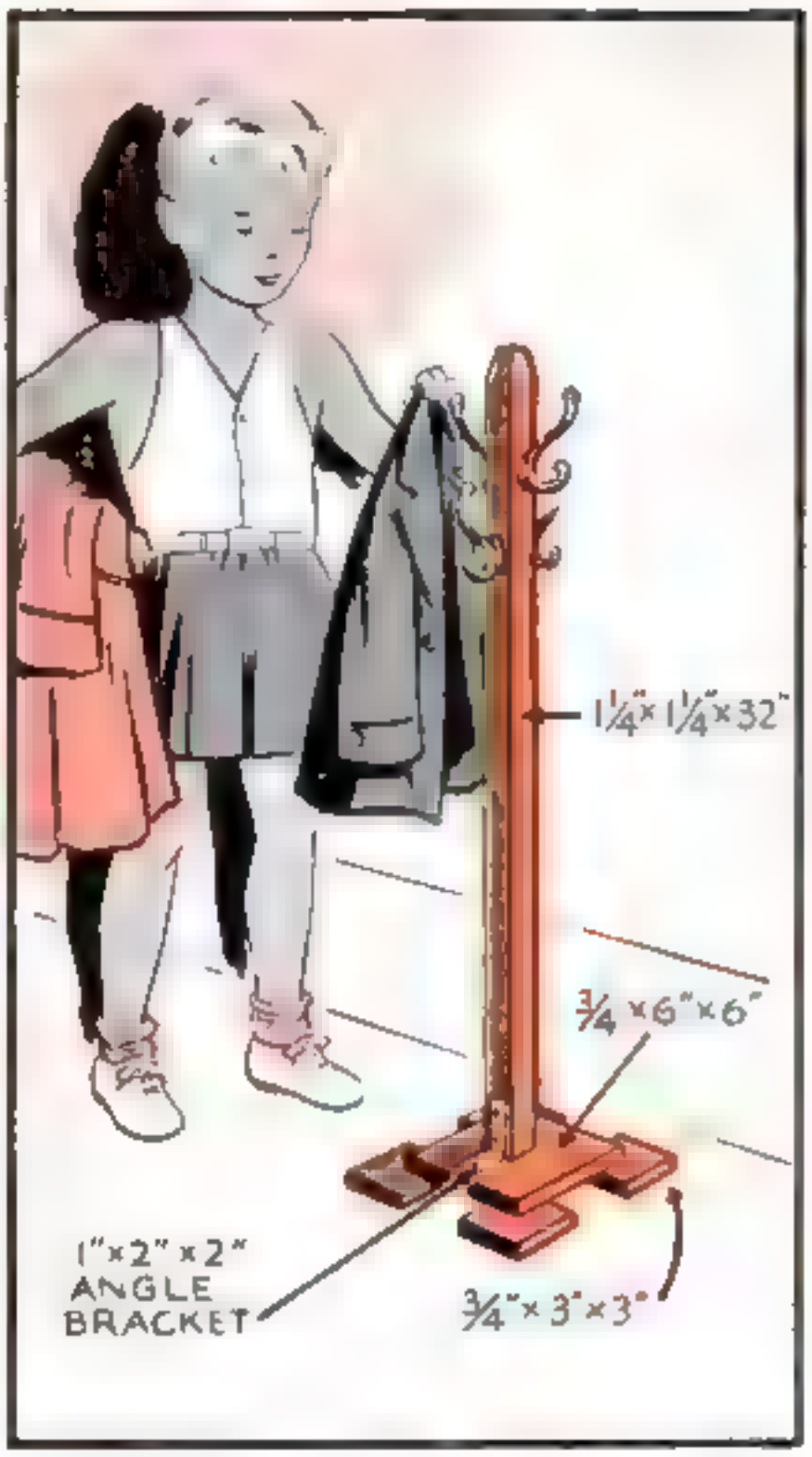


Tenoning Jig on Miter Gauge Provides Parallel Heads

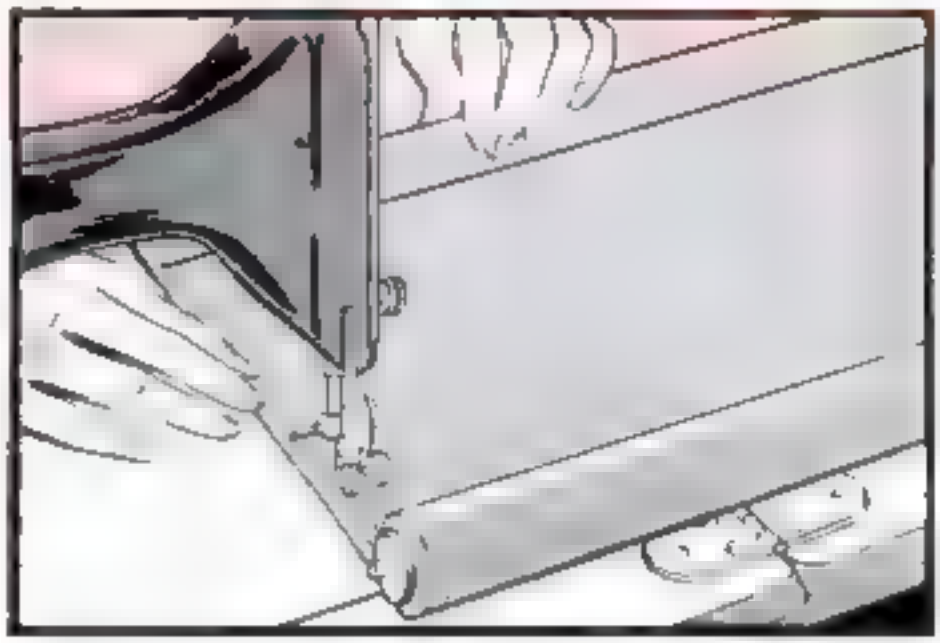
THIS jig permits the miter gauge to be kept in one groove for tenoning, as the working edge of the stock bears against a second parallel guide for cutting the opposite cheek. Not only does this prevent any misalignment of shoulders due to the stock being not quite parallel, but it also allows tapering stiles to be tenoned. Screw one auxiliary head fast to the miter gauge, the other to a plywood base, which is attached to the gauge bar with machine screws fitting the tapped holes. Both heads must be squared with the bar.

The stepped stop block is attached to a saddle having plywood sides, and the latter clamped to the fence with a setscrew inserted through a small reinforcing block. Bore the hole slightly undersize and let the screw cut its own threads. This block is more readily adjustable than one clamped to the table, and can be raised if a pattern is used.

KEEPING

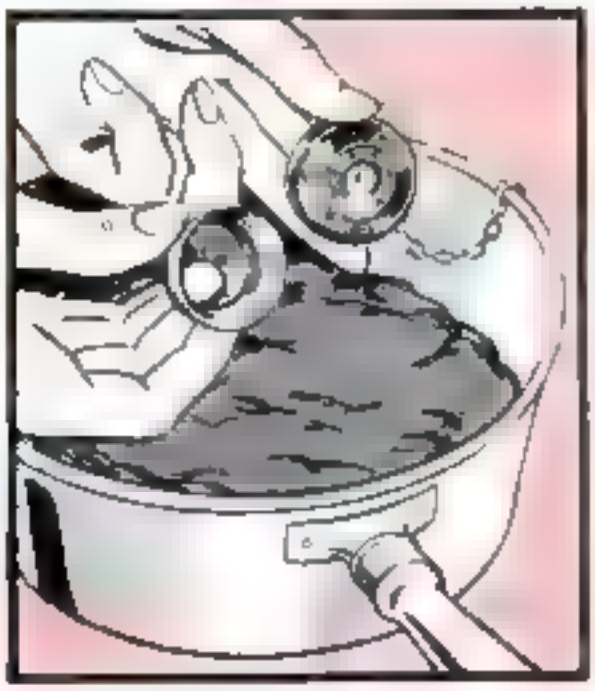


Orderly habits in hanging clothes where they can be found the next day may be taught a child with a clothes tree built to his size. Use pine or scraps, apply a maple oil stain and wipe it off until the desired color is obtained, then finish with shellac. The height may be changed to suit

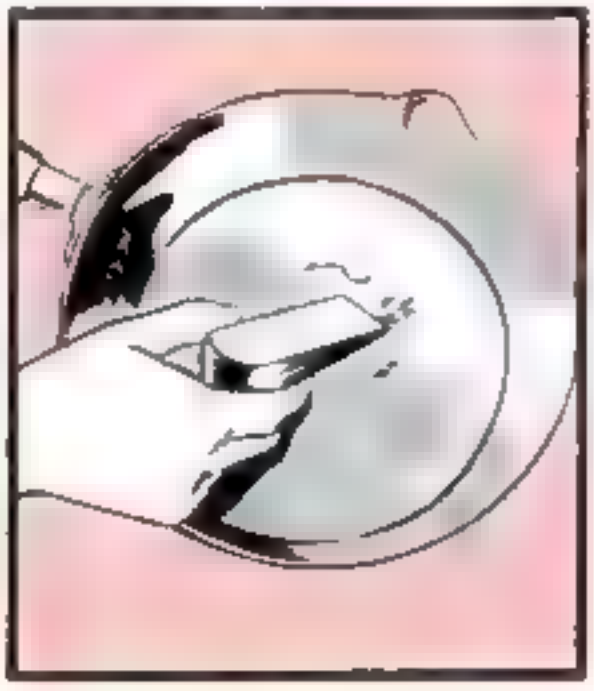


Two rows of machine stitching along each side of a paper window shade reinforce the edges and prevent tearing and fraying. Stitching may be done with the shade still attached to the roller by beginning at the top and rolling the shade as the work proceeds

Ice trays can be kept from sticking in the freezing unit of a refrigerator by coating them on the bottom and sides with a thin film of cooking or salad oil. The oil film does not retard freezing, but prevents the ice from sticking fast to the metal tray surface



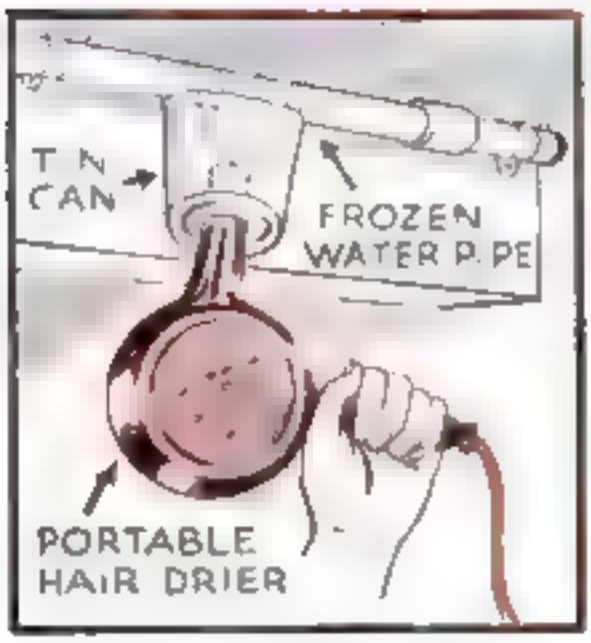
In order to use garlic sparingly, put it in a tea ball that can be fastened over the edge of the kettle for removal at any time



Food may be scraped off pots without danger of scratching by using a wedge-shaped piece of wood sanded well on all edges

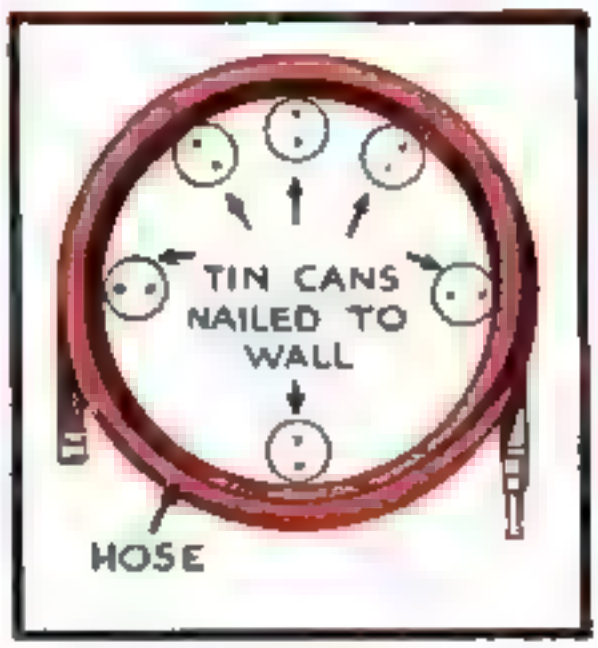
Washing will not stretch pockets and buttonholes in a sweater if they are basted together before the sweater is put in the water

THE HOME SHIPSHAPE



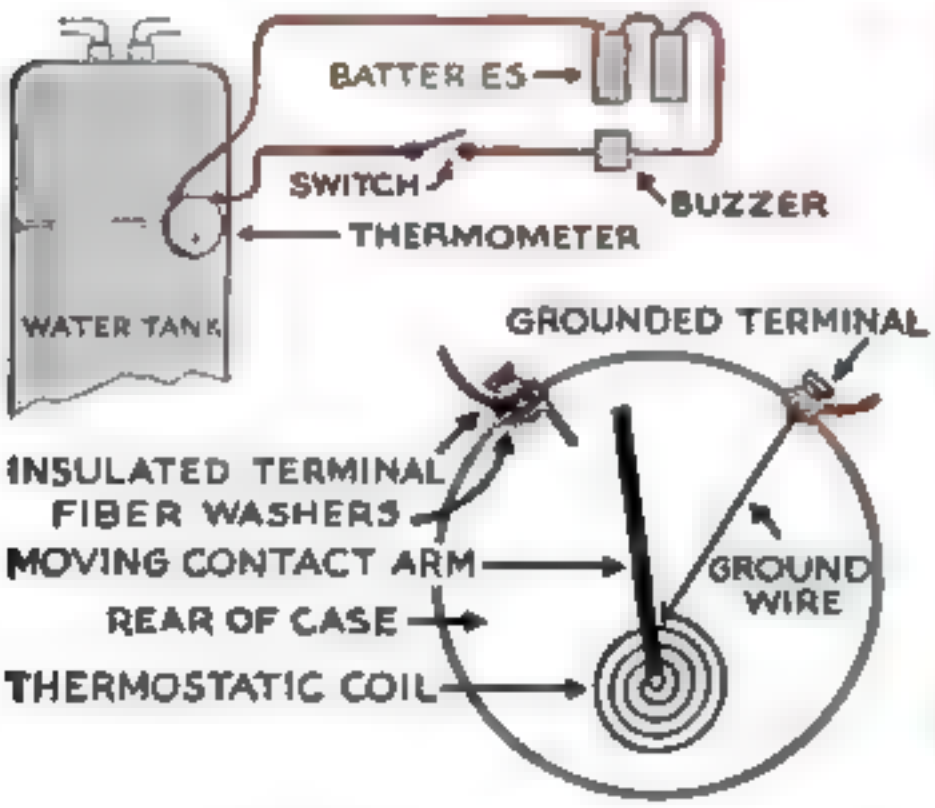
Frozen pipes can be thawed out by using a portable hair drier with a tin can cut to fit the nozzle. Flatten the open end of the can to concentrate the heat

Paraffin rubbed into rough spots in the lining or seams of shoes lessens friction and prevents blisters. Repeat for several days, and sprinkle with talcum

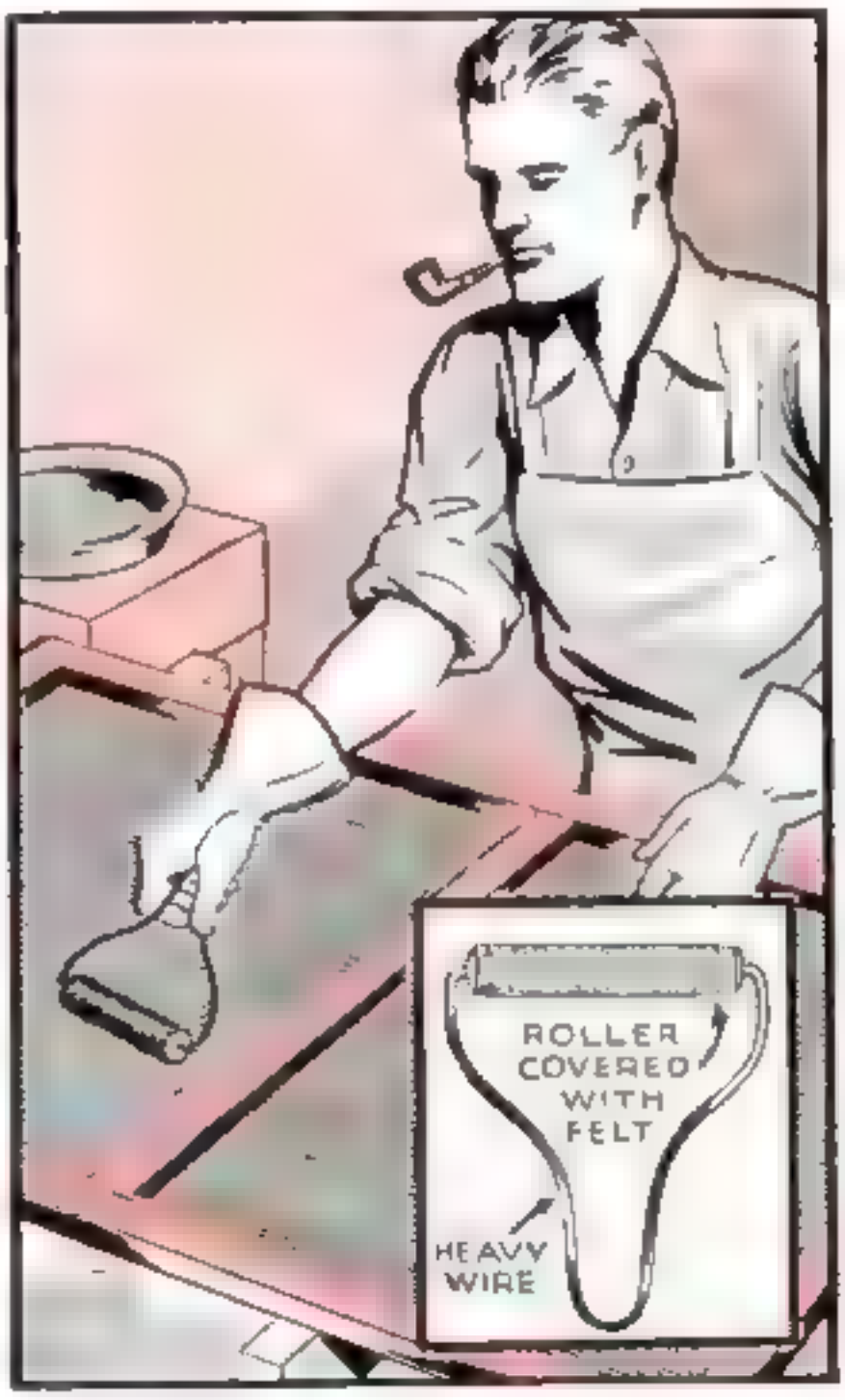


Six cans on a wall in the form of a 2' circle, as above, make a garden-hose rack. Punch screw or nail holes. A solid rod will be of help in driving in nails

When the threads holding the cap on a fountain pen are so worn that the cap keeps coming off, stick a piece of transparent cellulose tape over the threads on the barrel to increase the strength of the grip



The hot-water level in a boiler with no thermostatic control can be signaled automatically by adapting a dial-type thermometer and connecting it to a buzzer. Pry the back off the thermometer, attach terminals as shown, solder a metal contact arm to the back of the thermostatic coil, and solder on a ground wire. Strap the unit onto the tank about 3' from the top



Discard the wire from a package handle, cover the wood with felt, and then shape a coat hanger for a handle to make a roller for painting screens

Two-Rail Operation

AUTOMATIC SIGNALING

By
David Marshall

CAN we have two-rail operation and automatic signaling, too? Only a few years back the answer would have been a flat "no." It was pretty well known, of course, that the trick was not altogether impossible—two-rail pikes, completely signaled, were already in operation. But the apparatus required was so expensive that the average model railroader could not even dream of it.

In the past two or three years, however, new methods have been evolved—simple, reliable, and quite inexpensive. Circuit for circuit, signal for signal, the cost today will not exceed what you would ordinarily spend for signaling a three-rail road; or at least the difference will not be great enough to matter one way or the other.

Although these new methods represent a distinct improvement over the tried and true systems of the past, they have, unfortunately, one drawback. For reasons that will presently become apparent, signaling a two-rail system imposes a burden upon the operating efficiency of your trains. This is true, however, only within limits, and the limits can be wide enough. Stated broadly, the situation is that a resistor in every car must limit the length of trains or rob the locomotive of necessary power. But if you keep this point in mind, and stick to a certain balance, you will find the following method not only simple, reliable, and cheap, but also quite satisfactory.

NORMAL TRACK CIRCUITS. To approach our problem the easy way around, let us begin by recalling all we know about track circuits and automatic signaling in general. Let us build a normal three-rail pike and signal it the normal way, and having done this, let us convert the whole job to a two-rail pike.

In Fig. 1 we have the orthodox three-rail main line, broken up into blocks according to standard model-railroad practice. Of the two running rails, the upper one is continuous, serving as a ground for both power and track circuits. The lower one is broken up into insulated sections, each one extending the length of a block, which can be anywhere from 2,500 scale feet to three or four scale miles. The third rail is also sectionalized, to enable us to control trains in separate blocks separately. We have here three electric circuits, each one forever separate and distinct from the others, though all three may flow—never mixing—through common channels.

The power circuit is from the generator to the various controllers to the various third-rail sections, thence through the locomotive windings to the common running rail and so on back to the generator. The track circuit, on the other hand, is from the track battery to the common rail, where normally it is broken. Then, from every section of the control rail—the broken running rail—the track circuit is to a relay corresponding to that particular block, and from the relay back to the battery.

Thus the track circuit is normally open. But when a train—or a runaway box car, for that matter—enters a given block, it closes the gap between the common rail and the control rail; its own wheels and axles form a channel through which the electricity flows, and thus the circuit is completed. The track relay, normally inactive, is now energized, its armature drawn hard against the magnetic poles. That is the function of the track circuit—simply, under a given track condition, to energize a magnet. And, of course, when the track condition changes, when the train passes out of the block, the track circuit is broken, the relay becomes once more inactive, the armature returns to its normal position—drawn back by gravity or, on model railroads, by the pull of a spring.

The power circuit is under your control. From your perch before the operating panel you stop and start your trains at will. But over the track circuit you have no direct control. This is closed by the physical presence of a train in any given block; it is broken with the departure of the train. Likewise you have no direct control over the signal circuit, which in any case is not subject to interruption, but flows continuously through one light or the other depending upon whether the track relay is energized or inactive. All of which is made clear in Fig. 1.

COMBINING RAILS. Now let us take this whole setup, precisely as it stands in Fig. 1, and see what happens if we combine the third rail with the control rail which it so closely resembles. So far as the signal circuit is concerned, nothing at all will happen, for

this is independent of all the rails, and it stands to reason that the signals will continue to flash red and green in response to the movement back and forth of the track armatures. So we can forget the signal circuit entirely, and concern ourselves from now on simply with the track and power circuits, confident that, if we can get the relays to behave properly, the signals can be depended on to do likewise. To keep things simple, therefore, the signal circuit is omitted from Fig. 2, though the tie-in is sufficiently indicated.

In changing over from three-rail to two-rail, we retain the common rail precisely as it is. And we transfer to the control rail all the functions of the third rail, as indicated. Then we cross out all the duplicating wires, and find the track relays neatly tucked away between the power controls and control rail (Fig. 2). The relay is thus in series with the locomotive—and here we have two distinct situations. The locomotive draws power through the relay, so the relay must be energized when the locomotive is under way. But the locomotive, as a result of the hookup shown in Fig. 2, also pulls a certain minimum of electricity even when standing still, and this, though it is not enough to move the locomotive, is sufficient to keep the relay energized. And so the signal shows red as long as the block is occupied and whether the locomotive is in motion or halted. In short, the power is never shut off completely, and the rheostats at your control board must be adjusted accordingly. To stop a train, you simply reduce the power to a point below the minimum required to keep the locomotive going.

HALF-AND-HALF WHEELS. So far, then, as the locomotive goes—and with certain reservations—we have an adequate setup for automatic signaling. If we next equip all the cars with half-and-half wheels (steel on one side of the trucks and plastic on the other), and place a light or other resistor on each car, we have whole trains equipped for working the signals. The scheme is, of course, that the steel wheels of the forward truck shall ride on one rail, and the steel wheels of the after truck on the rail opposite, so that, even in the case of a box car, a current will forever flow from one rail through a resistor to the other rail. But since that can cause too great a drain on your power, it becomes expedient, at times, to cut out resistors by reversing one truck on each of several cars by having all the steel wheels ride on a single rail.

And so we have the beginning of an automatic system for a two-rail pike. As it stands, however, it is not perfect, though it may do for an HO pike. The trouble is, when we apply the scheme to an O-gauge road, that a relay sensitive enough to pick up on the minimum flow of current would burn out if sufficient power were shot through it to get the train really working. How this defect is remedied we shall explain later on.

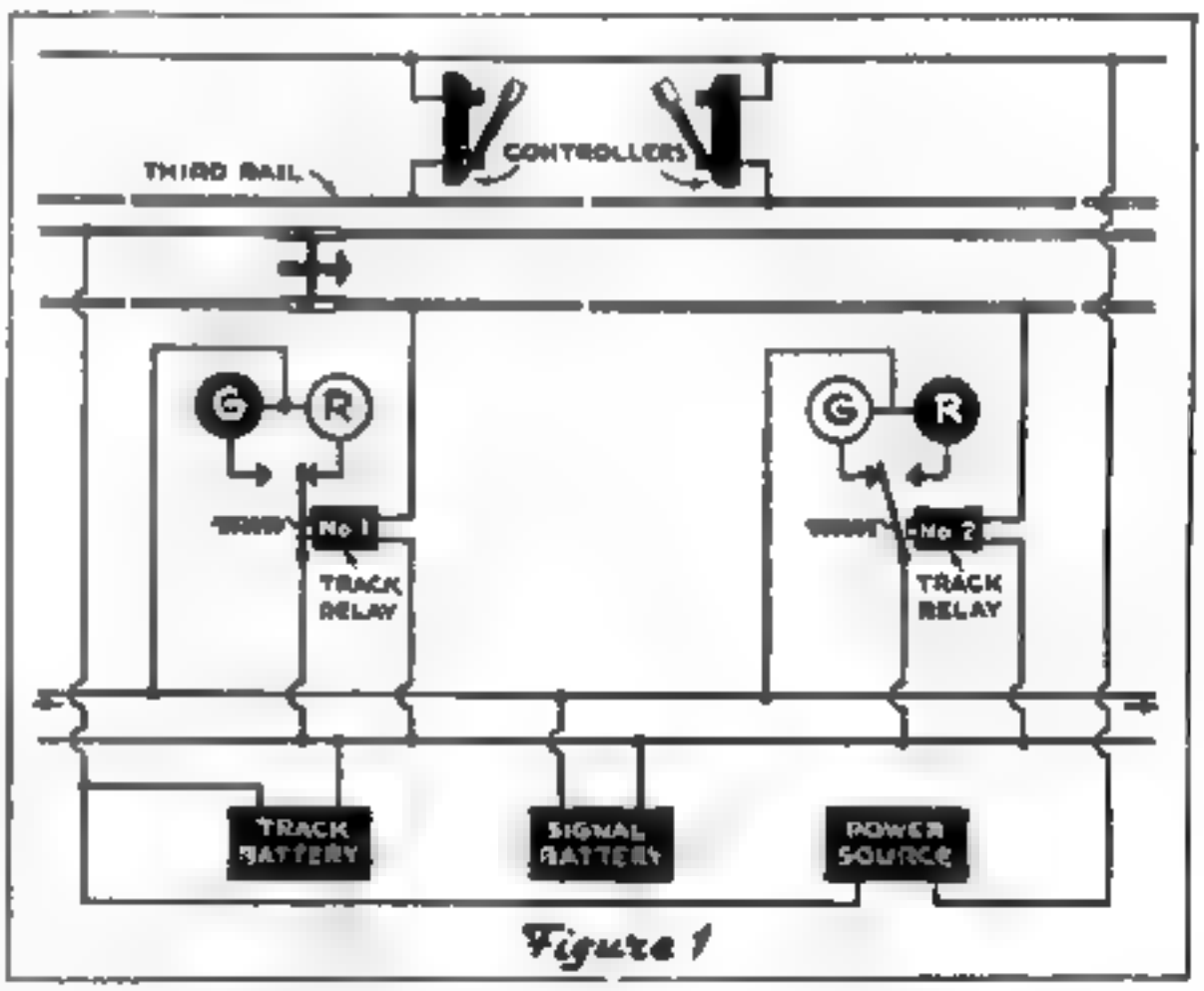


Figure 1

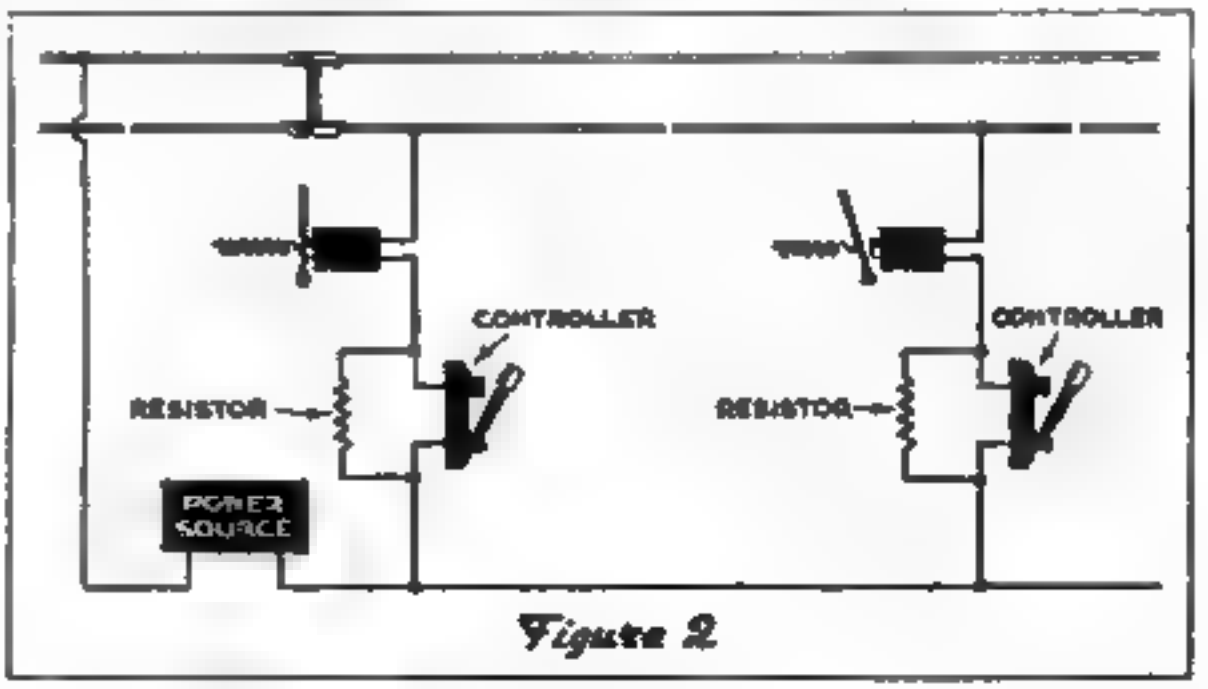


Figure 2

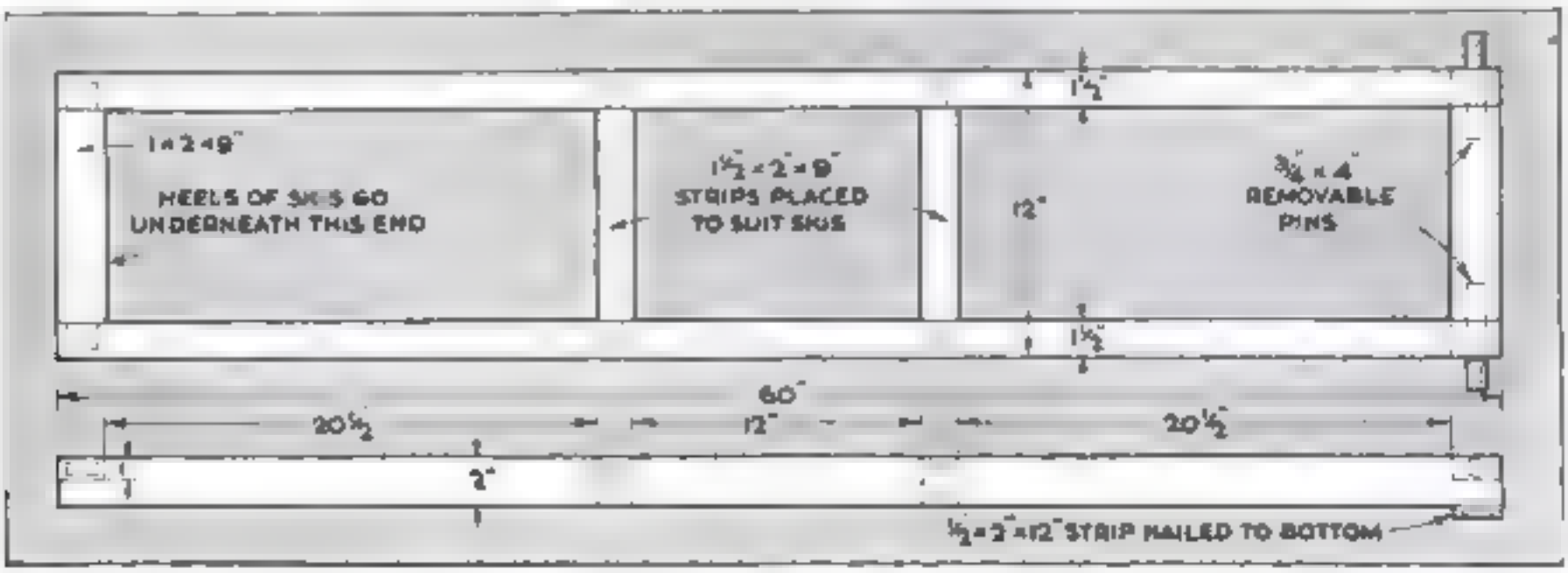
SIMPLE STORAGE RACK for SKIS

Sturdy Frame Prevents Warping

SKIS often present a difficult storage problem because of their length and shape. Although some experts prefer simply to tie them together and stand them in a corner, other skiers favor the use of a frame in which the skis can be clamped. Such a frame prevents them from becoming warped in the wrong direction, and so preserves their camber. If desired, extra clamps can be affixed to the tips of the skis to preserve the curvature of these parts.

The frame shown at the left can be built from any available stock such as 2" by 2" or 1½" by 2" lumber. Make the middle crosspieces just high enough to give the proper camber to the skis when they are placed over these and under the end pieces. Assemble the parts with mortise-and-tenon joints. One crosspiece at the toe end of the frame is removable and held in with wooden pins so that the skis can be put in the rack easily. The dimensions given are for a pair of 7' skis. For other sizes, simply build the rack in proportion.—R. H. JENKINS.

Left, the completed storage rack, showing skis in place. The strong frame protects them against being warped, scratched or otherwise damaged, and keeps them bent to the proper camber



HW 40

Commercial sulphur, produced first in Sicily, comes today from deposits under the earth of Texas and Louisiana. It is raised by melting it with hot water under pressure and forcing it to the surface by means of compressed air. Left, how a salt solution is analyzed by passing hydrogen sulphide through it. The white precipitate shows zinc is present

SULPHUR

CORNERSTONE OF MODERN INDUSTRY

TAKE sulphur from the chemist's kit of magic, and almost every manufactured article of daily life would either be altered or cease to exist. Sulphuric acid, which enters into more commercial processes than probably any other chemical, as well as other sulphur compounds, play important roles in many basic industries.

Called brimstone ("burning stone") by the ancients, sulphur was first found near volcanoes. Chemical theory has it that it forms in these regions due to the interaction of the gases hydrogen sulphide and sulphur dioxide. You can learn to generate these important compounds of sulphur, and to produce sulphur as a volcano does, with the simple chemicals and apparatus of your home laboratory.

Sulphur dioxide may be prepared by heating sodium sulphite and dilute sulphuric acid in a flask provided with a thistle tube and a delivery tube. You probably know its

How free sulphur is formed in the vicinity of volcanoes can be demonstrated in your home lab, as seen in photo at left. Sulphur dioxide is prepared by heating sodium sulphite with dilute sulphuric acid in the apparatus at the extreme left. Hydrogen sulphide is generated by the action of dilute hydrochloric acid on iron sulphide shown in the U-tube to the right. The two gases are led by tubes to the center jar, where their interaction produces sulphur

smell as the odor of burning sulphur. Hydrogen sulphide, recognizable by its "rotten-egg" smell, may be generated by an apparatus which stops production as soon as enough gas is obtained. This is made by filling the bottom of a U-tube with glass beads. In the outlet leg of this tube drop several pieces of iron sulphide, and pour in enough dilute hydrochloric acid to cover the sulphide.

As long as the acid is in contact with the sulphide, hydrogen sulphide is produced. If a pinchcock is applied to the delivery tube, gas pressure forces the acid away from the iron sulphide, and gas production automatically stops. Releasing the pinchcock starts generation again.

Set up these two generators together and lead a rubber tube from each to the bottom of a glass jar. Loose a little of both gases at once. As they mix, a cloud forms, and finely divided sulphur deposits on the sides and bottom of the jar. Keep your lab well ventilated during this experiment, and don't prolong it unnecessarily. These gases are evil-smelling, and may even be poisonous when breathed in large amounts.

An interesting characteristic of sulphur is that it can exist in three widely different physical forms. Dissolve some in carbon disulphide (keep this liquid far from any flame, as it is volatile and inflammable) and pour the solution in a dish to evaporate. The sulphur crystals that form are rhombic or octahedral in shape. This is the most common and stable form of sulphur.

Melt some sulphur, with the least heat possible, and pour it into a dish to cool. Now the crystals are thin, prismatic, and needle shaped. After standing, the crystals will change back to the rhombic form.

Melt sulphur and continue heating until it boils, however, and you temporarily change its basic characteristics. Pour some into water and it forms a tough, elastic mass resembling rubber. Gradually this too will change to the first crystalline form

Powdered sulphur may be made by holding a cold plate in the vapors of boiling sulphur, which condense as the familiar fine powder.

An extremely active element, sulphur combines directly with all metals, except gold and platinum, on the application of heat. The result of the reaction is a sulphide. By dropping iron filings or a bit of steel wool on some burning sulphur, you may witness a vivid demonstration of one form of combination, the end product in this case being iron sulphide. So much heat is liberated that the iron sparkles and glows as it unites with the sulphur.

Advantage may be taken of the fact that sulphur and iron combine to form black iron sulphide to create a durable black finish on small iron parts. Immerse the parts to be blackened in a solution of sulphur in warm turpentine (heat the turpentine over a water bath, and keep it away from all open flame); then heat them in the flame of a Bunsen burner. By repeating the immersion and heating, the coating may be built to the desired thickness.

Raw rubber is a gummy mass, sticky and shapeless—completely useless for most of the products with which we are familiar. Sulphur is the chemical that gives this mass strength and life; the process is known as

Left above, if sulphur is heated in an open tin until it blazes, and steel wool or filings are dropped into it, the resulting combination is iron sulphide. Right above, lead paint, darkened by the presence of sulphur in the air, may be whitened again by oxidizing the surface with a solution of hydrogen peroxide

vulcanization. By regulating the amount of sulphur and the temperature and length of time of vulcanization, the elasticity, toughness, and hardness of rubber may be accurately controlled.

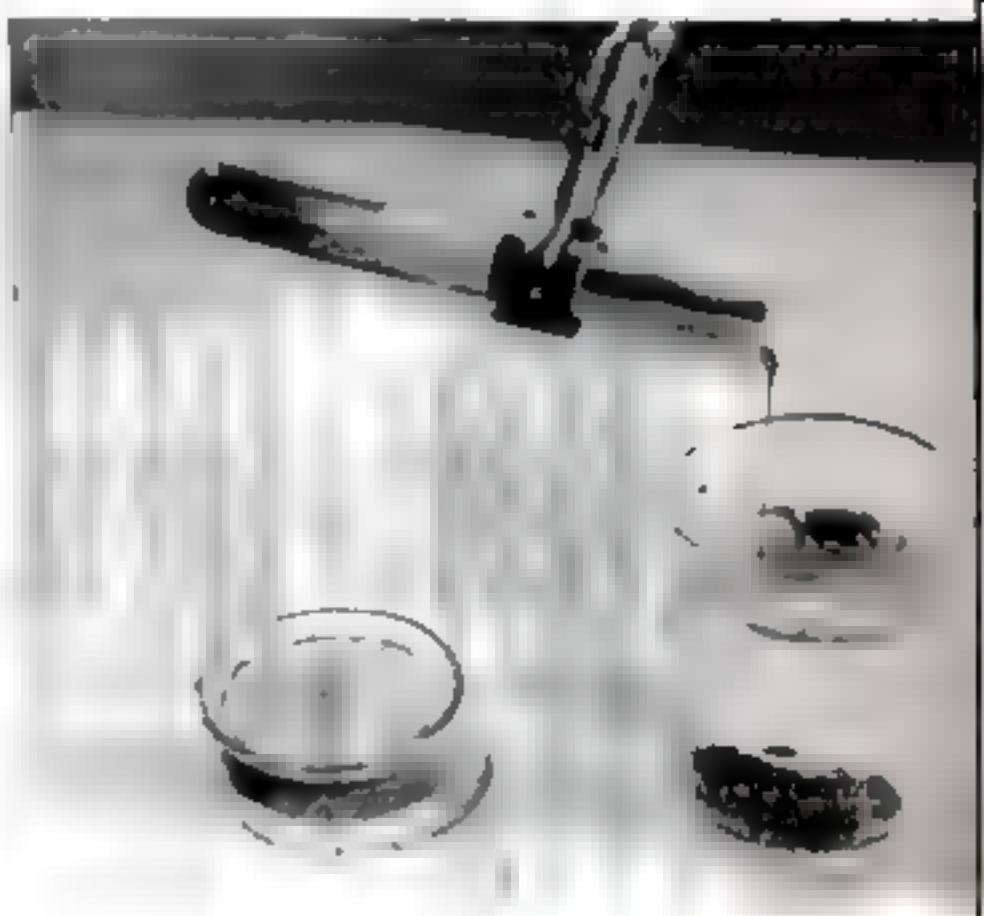
The process of vulcanization originated in 1839, when Charles Goodyear accidentally spilled a mixture of rubber and sulphur on the top of a hot stove. The product formed was the forerunner of the entire rubber industry.

You can repeat this experiment with the aid of a little rubber cement and powdered sulphur. Heat a few drops of rubber cement over a small flame, and add a few grains of sulphur. When the mixture has been heated sufficiently to melt the sulphur and evaporate the solvent of the cement, the patch may be peeled from the tin. This new product displays the stretch and tensile strength of rubber.

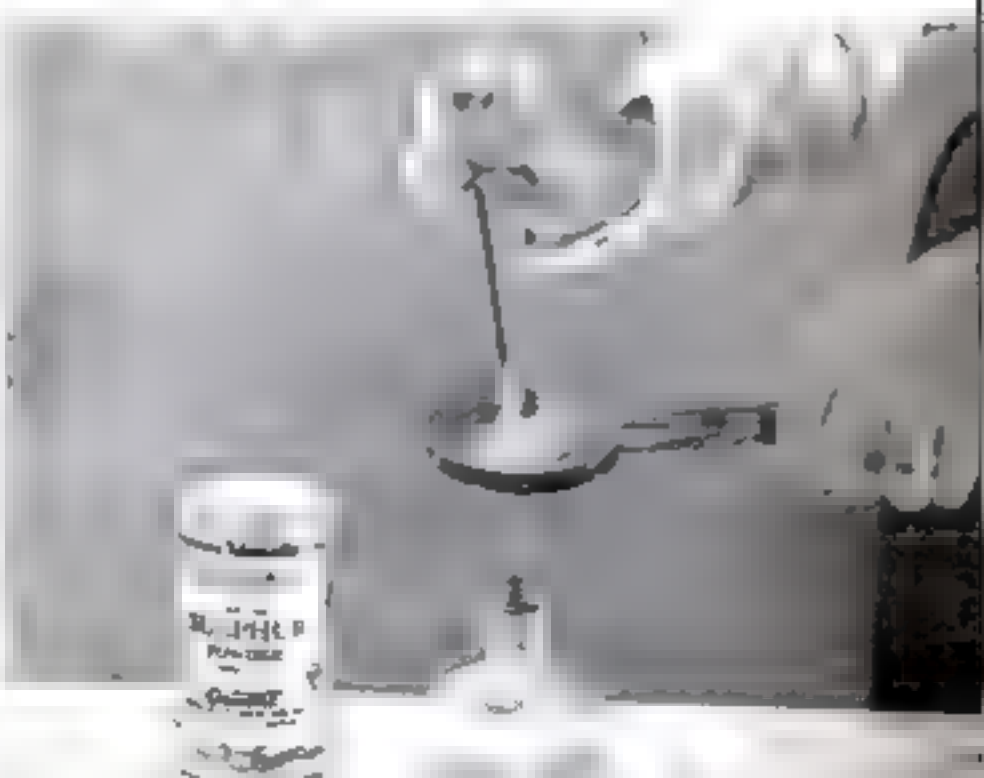
Hydrogen sulphide gas is a great help in the laboratory in the detection of metals. When it is passed through salt solutions of various metals, colored sulphides may be precipitated. From the color and solubility of these sulphides it is possible to identify certain metals.

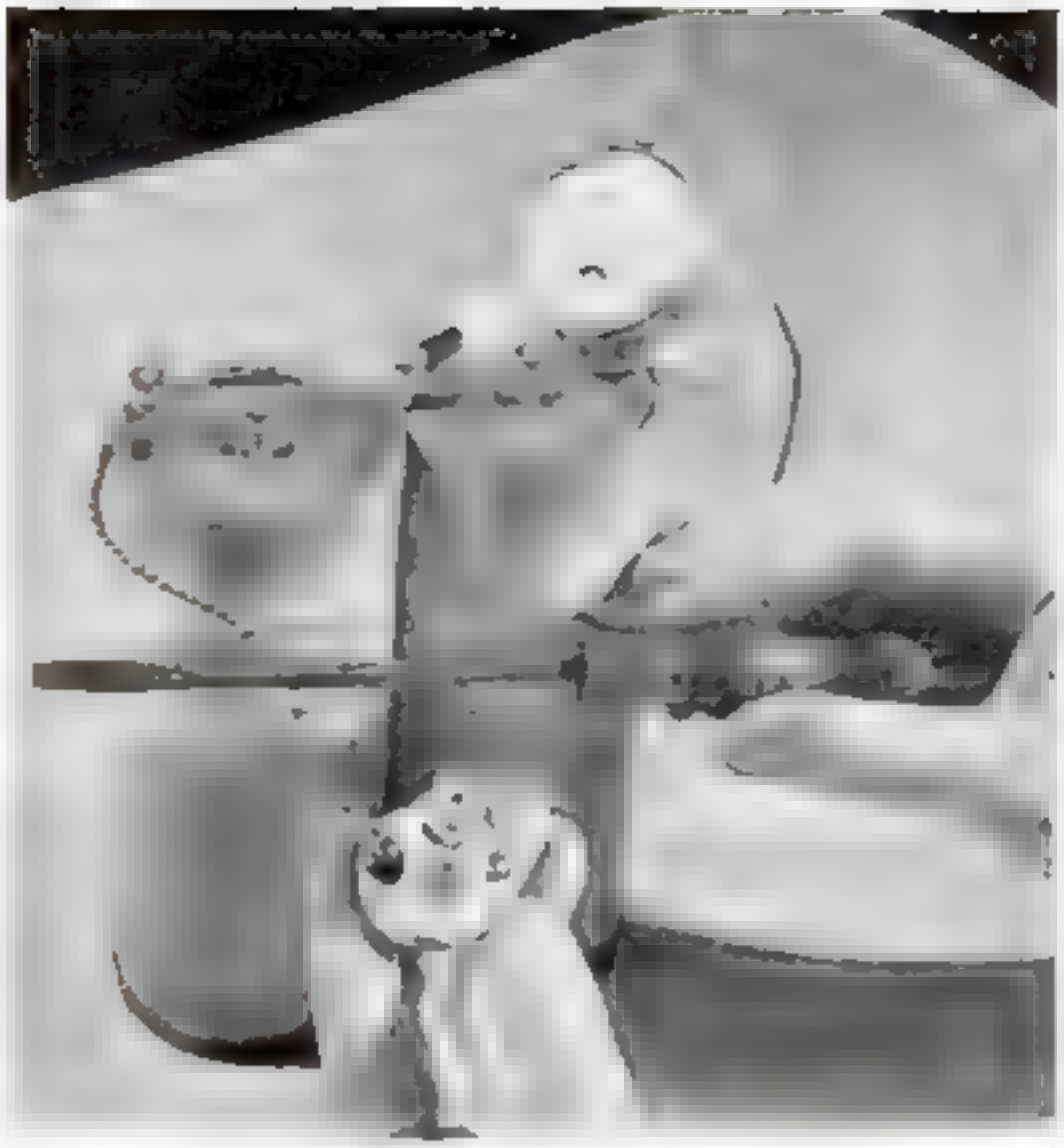
Pass some of the gas from your hydrogen sulphide generator into a solution containing some unknown salt. If the precipitate is white and will dissolve in hydrochloric acid, the metal is zinc. If it is brown-black and soluble, it is copper. If black and insoluble, it is mercury. If black and soluble, it is lead.

Minute amounts of hydrogen sulphide in the air turn silverware black, and often cause white-lead paints to darken due to the formation of lead sulphide. Paint so discolored may often be whitened by oxidizing the surface with hydrogen peroxide, changing the sulphide to *sulphate*, which is pure white.—KENNETH SWEZEY.



Two forms of sulphur are seen in the above photo. One assumes the shape of crystals; the other is a plastic, rubbery mass. Learn how sulphur acts on rubber by mixing powdered sulphur with rubber cement and heating the mixture over a small flame, as shown below

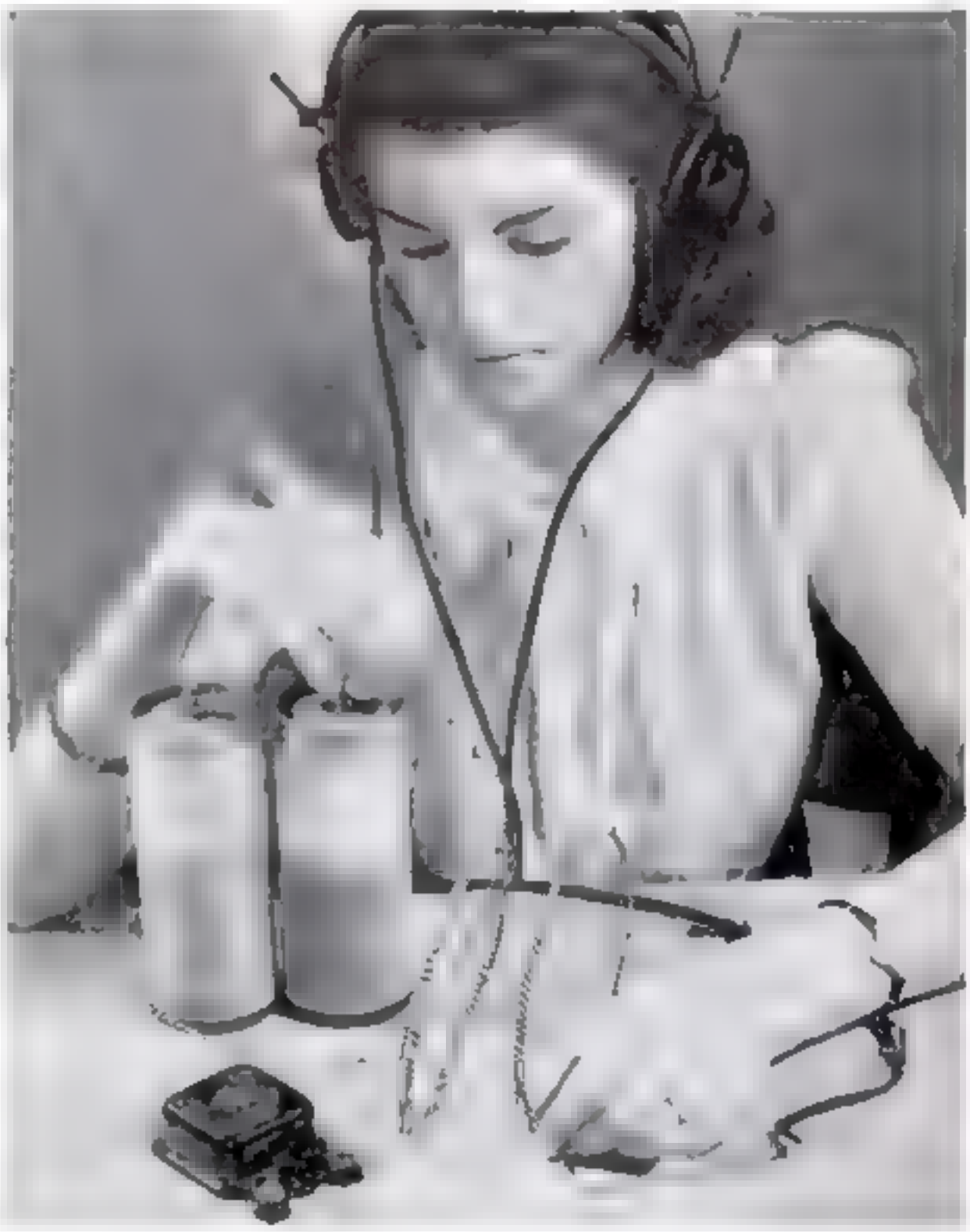




home EXPERIMENTS

SHORT CIRCUITS and their effects can be demonstrated with two dry cells, a small battery bulb, and a battery-testing meter. First, connect the bulb in series with the dry cells and the meter. Now scrape a bare spot on the wires leading to the bulb and away from it. Short-circuit the bulb by connecting these bare spots with a metal object. The resistance of the bulb gone, the hand of the meter jumps ahead. What had been a harmless, controlled current, now becomes an excessive one that will soon exhaust the cells. In the case of house current, it might cause a fire.

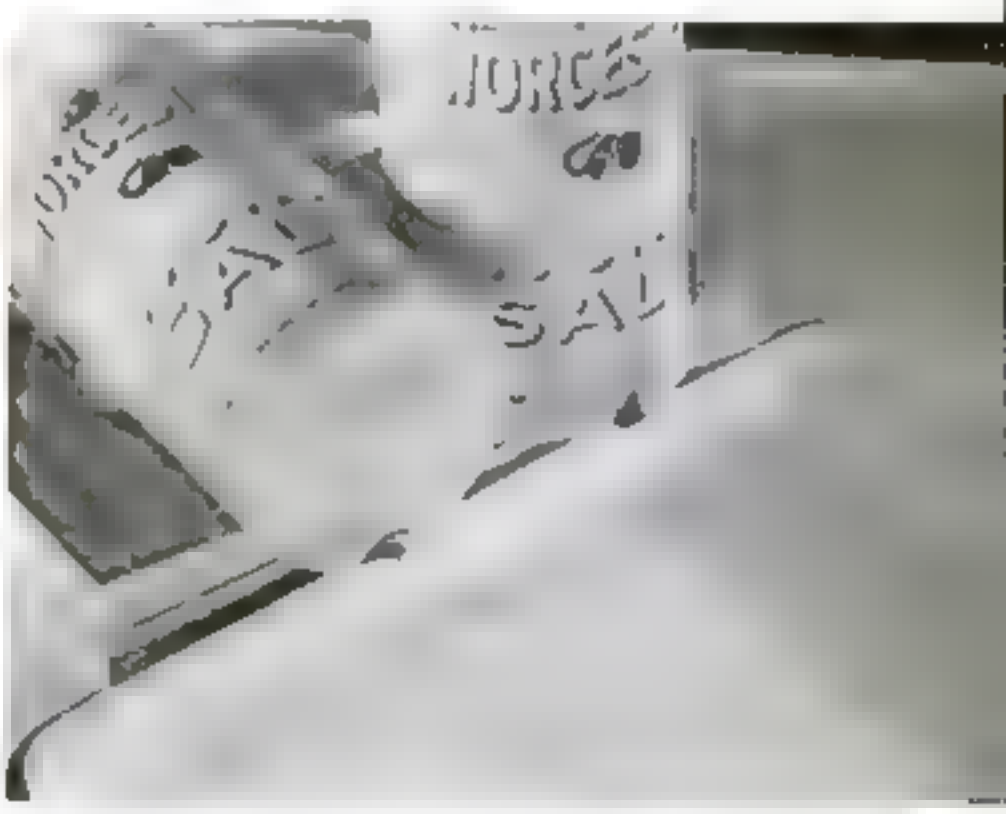
RADIO STATIC is caused by atmospheric electricity and by radiations and fluctuating magnetic fields from doorbells, telephone equipment, street-car lines, X-ray apparatus, and so forth. How static can affect your receiving set can be demonstrated with the simple setup shown at the right. Make a loop of several turns of bell wire, to represent your radio aerial, and connect the ends to a pair of headphones. Set up a similar coil a few inches away, and parallel to it. Connect one end of the second coil to one terminal of a dry cell, scrape the other end over the second terminal, and distinct clicks and raspings will be heard in the headphones. Connect a bell or buzzer in series with the second coil, and you will hear a buzzing in the phones. In both cases the noise in the headphones is caused by electrical currents induced in the "aerial." Similarly, electric wires running parallel to your radio aerial cause induced currents every time a switch is opened or closed or a bell is rung, even though the wires and aerial are insulated from one another.



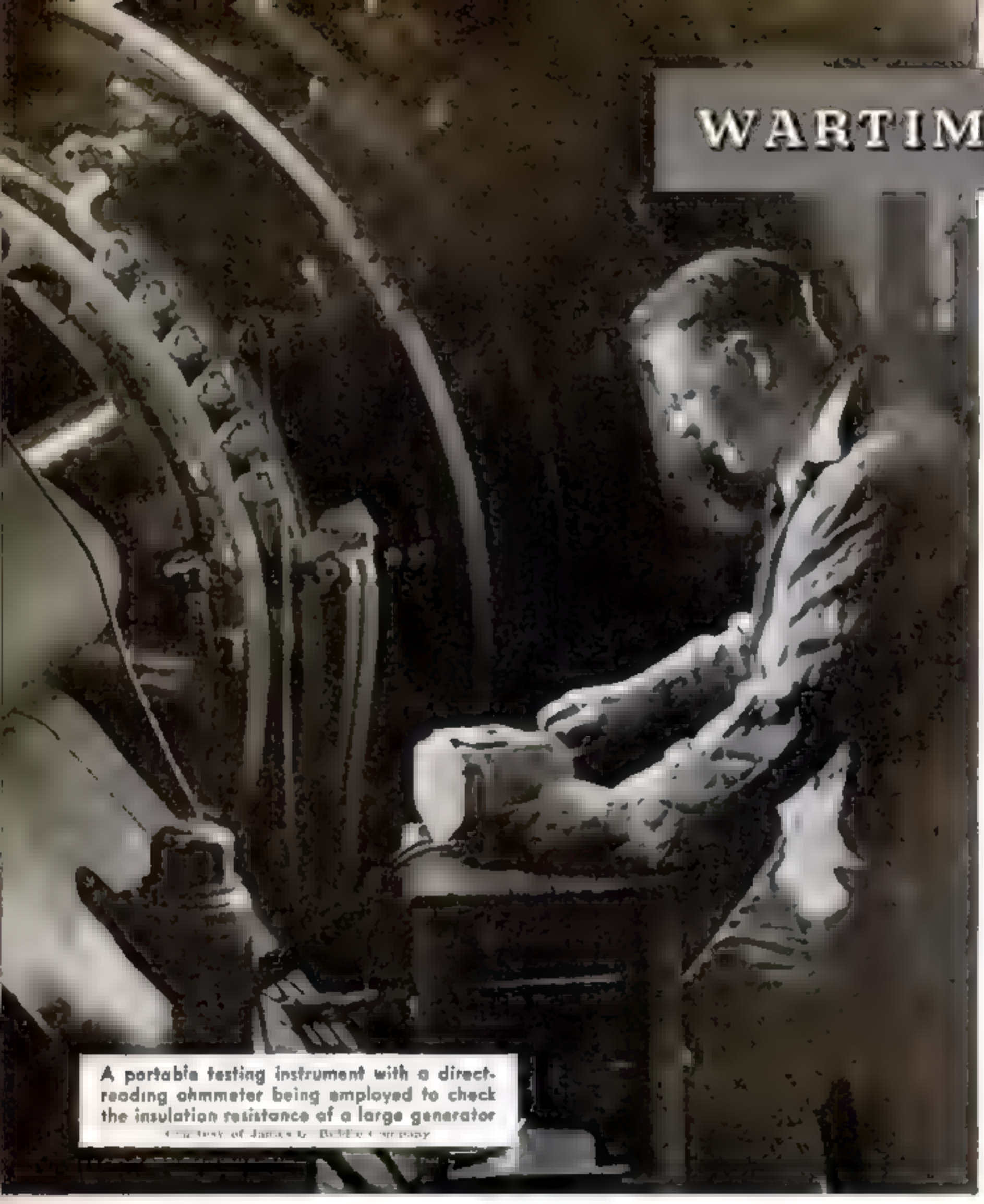
WHY BATTERIES "PICK UP" after a rest is illustrated at the right, with a transparent experimental cell. Arrange a rod of carbon, and another of zinc, in a glass containing a strong solution of sal ammoniac. If you connect a small 1½-volt bulb to the two terminals the bulb will light brightly at first, but will gradually lose its brightnesa until it goes out completely. Observe the carbon rod carefully, and you will see just what causes the diminution in current. As soon as the bulb is connected in the circuit, bubblea of gas begin to collect on the carbon, clinging to the rod until it is almost completely covered. These bubblea are filled with hydrogen, and their effect is the dual one of partly insulating the carbon from the solution and of creating a contrary potential in the cell. Together, they reduce the voltage of the cell and, consequently, the current. To prove that this is correct, merely scrape off the hydrogen bubblea, and the lamp will light brightly again. In dry cells, "scraping" of the gas bubbles is accomplished by chemical, rather than by mechanical action. It is brought about by a depolarizer, such as manganese dioxide.

MAGNETIC LINES OF FORCE around conductors carrying an electric current can be demonstrated with a coil of bell wire, two dry cells, and a small magnetic compass. It is a good idea to wind the coil as large as you can conveniently make it, since the magnetic fields are likely to interfere with each other if the coil is too small. By moving the compass about on the cardboard platform, placed as in the photograph below, the needle can be made to indicate both the direction and the arrangement of the lines of magnetic force, which can be drawn easily with a pencil. Reversing the battery connections will also reverse the direction in which the current enters and leaves the coil. The lines of force, and therefore the compass needle, will change accordingly.

IS MORE ELECTRICITY obtainable from dry cells in series, or from cells in parallel? An analogy answers this question. Fill two containers, both having a hole punched in the bottom, with water. Arrange them as below. The greater height of the upright one results in greater pressure, and the water flows out more quickly. The lower pressure of the horizontal one results in a slower flow, which continues longer. Similarly, two dry cells in series produce greater electrical pressure, causing more current to flow in a given time. Connect them in parallel, and only half the current flows, but for a longer time. In both cases the total amount of electricity is the same.



WARTIME



A portable testing instrument with a direct-reading ohmmeter being employed to check the insulation resistance of a large generator

Courtesy of James G. Biddle Company

PROPER MAINTENANCE METHODS INSURE TOP PERFORMANCE

By HAROLD P. STRAND

WITH most factories engaged in war production on a 24-hour schedule, it is more imperative than ever that the electric motors which drive their machinery should be given every care. A motor breakdown may slow up production or even close an entire department for a time.

Under present conditions, many motors must be run the clock around with no relief periods. This skyrockets their average working time from the normal figure of about 1,800 hours a year to over 8,700 hours. No wonder inspection, lubrication, cleaning, and adjustment must be quadrupled if motors are to last for the duration!

In the home workshop, motors are not likely to be overworked, but since new ones cannot be bought readily, the shop owner had better take good care of those he has. Dampness, acid fumes, dirt and dust,

CARE OF ELECTRIC MOTORS

abrasive particles, and vibration are natural enemies of motors, as are overloading, misalignment, lack of lubrication, friction, and stray oil. Operating a motor with badly worn bearings is another form of abuse. In the box below are given some hints of value.

As most motor failures are electrical rather than mechanical, one of the most important pieces of equipment for the maintenance man is an insulation-resistance tester. This device consists of a hand-operated, direct-current generator capable of supplying a potential of 500 volts, mounted in a carrying case with a direct-reading meter calibrated in ohms and megohms. For testing apparatus rated above 750 volts, a 2,500-volt generator is available.

With such a tester, it is easy to keep a constant check on the insulation resistance of motors, generators, starters, and wiring so that breakdowns can be avoided. One test lead is connected to "ground" and the other, in the case of motors and generators, is clipped to a brush holder. By lifting or removing the brushes, the field can be tested separately from the armature.

All forms of both D.C. and A.C. apparatus and all wiring circuits should be tested periodically and charts kept of the meter readings. Motors that have been rewound should be given an insulation test before the usual dielectric-strength test with high voltage. If the reading is low on the insulation test, it is not good practice to use the high voltage until the windings have been dried or other measures have been taken to raise the reading, so as to avoid permanent damage. Following the application of high voltage, the insulation tester should be used again to make sure the insulation has not been strained to the point of puncture or breakdown.

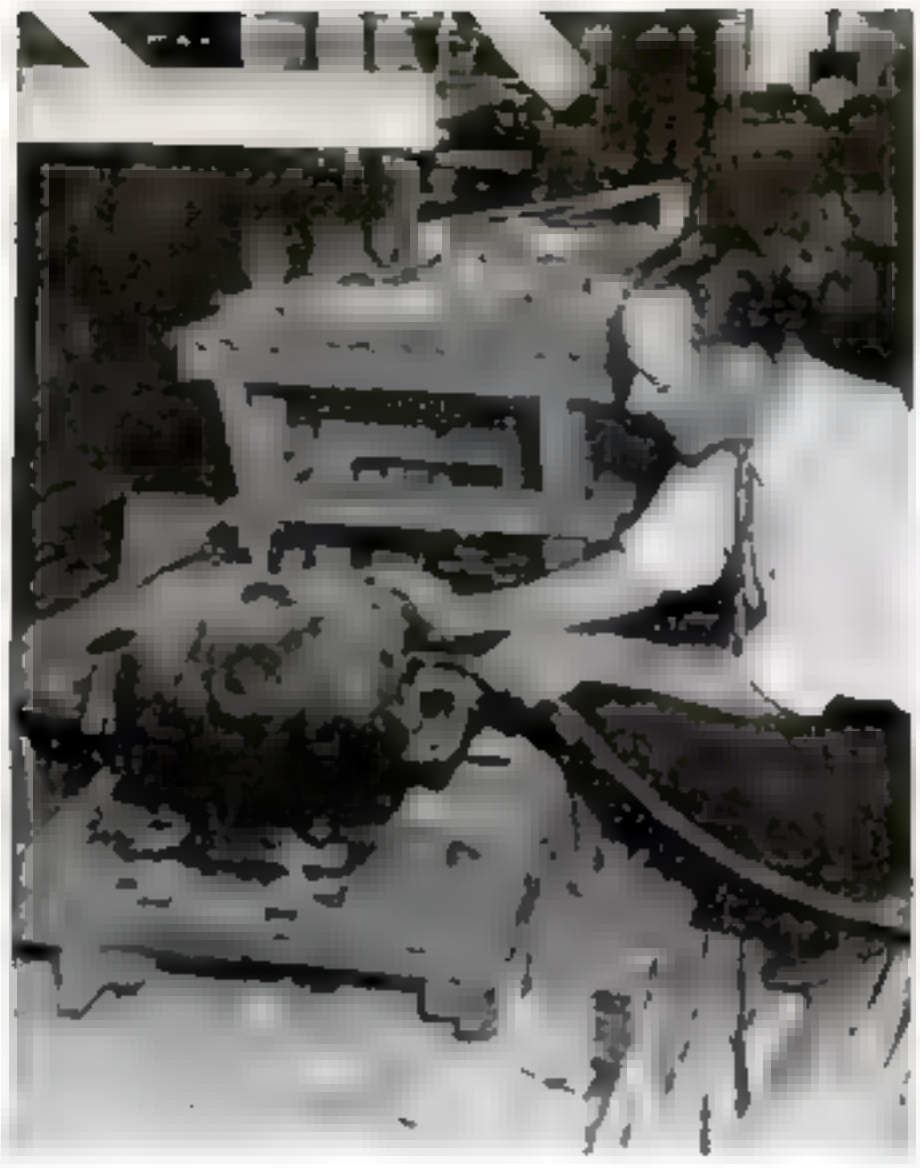
The scale of a typical resistance tester reads from 10,000 ohms to 100 megohms, and is suitable for most maintenance work under 750 volts. It can be seen that this instrument starts where most bell-ringing magnetos leave off (10,000 ohms) and as one megohm equals 1,000,000 ohms, the condition of insulation can be quite definitely determined with a top limit of 100 megohms. The readings to be expected will vary with the type of apparatus, temperature of the machine, humidity and operating conditions. Motors, for example, when tested after a long run and consequently warm, will show a lower reading than when cold. Cleanliness of the parts also has a bearing on the case, and when readings are low and there are no serious defects otherwise, washing with a solvent and drying out may raise the reading considerably. Motors in

SERVICING HOME WORKSHOP MOTORS

- Keep commutators of both A. C. and D. C. commutator-type motors clean with fine sandpaper.
- If deep pitting or ridges are evident, turn commutator down in the lathe.
- Replace brushes worn too short to make good contact. Set tension springs to provide only enough pressure for nonsparking operation.
- Keep brush guides clean and free from oil.
- Should sparking persist after brushes are correctly adjusted, try undercutting the mica. If this does not end sparking, test the armature on a growler.
- Use the oil specified by the motor manufacturer. Avoid spilling it into or on the motor.
- Blow out dirt, dust, shavings, chips, or sawdust frequently.
- Cover idle motors to keep out dust.
- Keep mounting bolts tight to prevent vibration.
- Do not allow belt tension to be greater than necessary.

IF A MOTOR seems to run hotter than usual, check with a suitable thermometer and compare the temperature with that specified on the name plate as normal. If a commutator-type motor has run hot, examine the soldered commutator leads. Should solder "whiskers" be evident or solder be spattered inside the housing, resoldering would be advisable. Overheating of the commutator may be caused by using brushes of the wrong grade or poorly fitted brushes.

This motor on a wood shaper is covered with sawdust after a day's run, despite its shield. Damage is likely if such clogging dust is not blown out



Air cleaning of such shop motors as this should be a daily chore. A compressor or electric blower is ideal, but even a hand bellows can be employed

damp places are hard to keep dry enough to give a satisfactory reading unless given special care as described below.

The actual value on the scale in megohms is not so important as are comparative readings over a period of time, as noted from the charts. However, many engineers and practical electricians take the value of one megohm per 1,000 volts as a standard for a low limit. Some types of apparatus will show considerably higher tests and others operating under adverse conditions may be safely run at lower values, but any sudden or even gradual lowering in resistance is an indication that something is wrong. Unlike a bell-ringing magneto, which delivers alternating current, a D.C. tester of this type is not short-circuited by the capacitance of a large machine or a long cable, nor choked by inductance, as is often the case with an A.C. tester, resulting in a false diagnosis of the trouble. In using either machine, make sure the current is off on the line or apparatus under test.

Water, or dampness, is the cause of many electrical failures. Avoid spraying water on a motor or splashing water close to it. Keep a motor subject to spray or splashing covered with a protecting box or hood at all times or, better still, use a totally enclosed or splashproof motor. Make frequent tests with the resistance meter, and when the reading shows a decline, take steps to dry out the motor before damage is done. This can be done in an oven under controlled temperature or by locking the rotor and sending a low-voltage current through the windings. Another method is to cover the motor with a tarpaulin having ventilation holes at top and bottom, and blow hot air through the motor. Make frequent resistance tests to avoid unnecessary loss of time and possible overbaking, which may cause insulation to become brittle and crumble.

Where shop motors are choked with sawdust, air pressure from either a compressor or a hand bellows should be applied to blow this waste matter out after each day's run. If allowed to remain, it will cause overheating of the motor and possibly a burnout. Totally enclosed, fan-cooled motors should be used for this class of service.

Overloading a motor willfully should be a punishable offense. The first indication of it is usually a decided increase in temperature and a blowing of fuses or overload relays. To determine whether or not overload is present, connect an ammeter in series with one lead while the motor is carrying full load, and note the reading in amperes. If this is not more than the normal current stated on the name plate, it can be assumed that the motor is not overloaded.

Several things other than the external load given a motor can result in overloading. Lack of lubrication can cause friction

The contact fingers of magnetic controllers need inspection and cleaning at regular intervals for protection against burn-outs due to bad contacts

The lubrication of a 5-h. p. motor on a big power saw is being checked here. Oil is added to keep the cup at the side of the bearing nearly full

at the bearings. Worn bearings may allow the rotor to rub on the field poles. An overly tight belt can make a motor labor. Dirt and other waste matter inside the housing may have the same effect. Misalignment of pulleys, chain sprockets, or gears will cause friction, vibration, and inefficient operation. If after all these points have been checked, overload is still present, there is nothing else to do but substitute a larger motor for the work. Don't continue using an undersized motor by overloading it.

Lubrication is one of the most important factors in keeping motors on the job. In bearings that have oil rings, always use oil —never grease. Check the rings occasionally to make sure they turn freely. Drain the wells at intervals and refill with clean, fresh lubricant. Keep the level at all times just below the top of the overflow cup at the side, which level should be determined when the motor is at rest. Use an oil of the correct grade for the size of the motor. Too light an oil will be squeezed out from between the shaft and the bearing surface and allow metal-to-metal contact with resulting damage.

Waste-packed bearings also use oil, and this should be renewed occasionally. Antifriction bearings such as ball bearings require grease. This should be injected as required, for damage to the polished surfaces is sure to result if such bearings run dry. When ball bearings wear to a point where play or shake is noticeable, new ones should be installed without delay. If any dirt or abrasive particles ever get into the bearings of a motor, stop the machine at once and thoroughly wash out the parts with carbon tetrachloride; then refill with new lubricant.

A point often overlooked in the maintenance of motors is the possibility of three-phase motors running "single phase" due to a blown fuse or dirty contacts in the control switch or breaker. When this happens, the motor will continue to operate, but with a gradual increase in temperature until fuses blow, relays open, or perhaps the motor burns out. To guard against this hazard, check fuses frequently and clean all contacts in both fuse panel and control switches regularly. Often it will be found that fuse clips are loose, making poor contact. Control contacts may be pitted and burned. They should be cleaned or new contacts obtained and installed.

Another source of trouble in motors is vibration. Many times the rotor is out of balance, especially following an armature repair. This can be checked by testing the rotor on parallel knife edges or bars. It should not come to rest at any particular point repeatedly. If it does, it has a heavy side. The usual remedy is to drill a few shallow holes in the armature core at this point until it balances.

FIRST STEPS IN ELECTRONICS

PART I — THE ELECTRON

By CHARLES I. HELLMAN

Physics Instructor, Bronx High School of Science, New York

ELECTRONS, although the smallest particles in existence, are doing a big job in helping Uncle Sam win this war. The problem of producing them and putting them through their paces is a comparatively new branch of science called *electronics*.

Through this and subsequent articles, those readers with a general interest in science may gain an understanding of how electronics is helping in our war effort. Experimenters will discover in this most fascinating of modern sciences a ready field for new activities. And men and women who wish to expand their knowledge of electronic applications in war industry will find it essential to study and master the fundamentals.

Electrons are literally everywhere, for they are constituents of matter. Free electrons abound even in "empty" interplanetary space. Surcharges of electrons create the beauty of the northern lights and the flash of lightning. Electrons are also given off by radium and other radioactive substances.

We ourselves are constantly freeing electrons from ordinary matter, and putting them in motion. Comb your hair briskly with a hard-rubber comb on a dry winter day, and the friction strikes electrons loose from the atoms comprising your hair. These cling to the comb, which we then say is "electrified."

An electric current consists of electrons in motion. Snap an electric-light switch, and billions of electrons flow through the filament. Millions crowd upon the negative terminal of the dry cell you buy for a dime, and are ready to flow forth, through the bulb of your flashlight, and back to the positive terminal, at the touch of your finger on the button.

Early in the science of electricity it was rather arbitrarily decided that the flow of current was from the positive to the negative. Today it is known that the electron flow constituting the current is exactly opposite to this—from the negative to the positive. It is an excess of electrons that constitutes a negative charge. Matter that has been stripped of some of its electrons is said to have a positive charge, and will attract electrons from whatever source it can. The electron flow is thus always from the negative to the positive.

A source of electrons most of us are familiar with is the cathode or filament of a vacuum tube. As electronics has made perhaps its greatest contributions in the field of radio communication, it is interesting to note that our modern knowledge of the electron began with an accidental discovery made during the first demonstration of wireless waves.

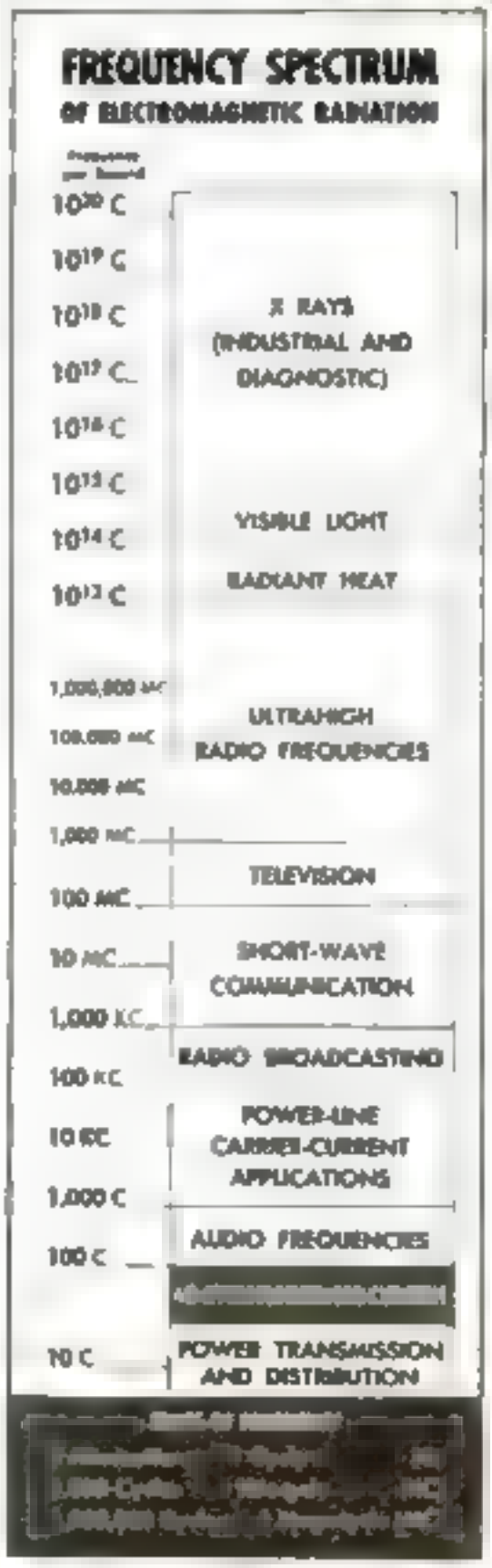
In 1864 James Clerk-Maxwell, in attempting to explain how a magnet would pick up a piece of iron at a distance, or how an electrified rubber rod could attract pieces of paper at a distance, propounded a startling theory. By mathematical calculations he found that the speed with which a magnetic disturbance traveled was nearly that of light, and he therefore concluded that light itself was an electromagnetic disturbance.

Since light can be reflected, focused, and transmitted through space, and since electromagnetic disturbances seemed to be of the same nature as light, Clerk-Maxwell's discovery indicated that it might be possible

to produce an electromagnetic wave having somewhat the same properties as light. As a consequence of this work, many physicists were stimulated to experiment along these lines, and in 1887 Heinrich Rudolph Hertz, after painstaking work, succeeded in producing waves that completely confirmed Clerk-Maxwell's theories. The apparatus he used for some of his experiments is shown on the facing page. Using this equipment, he was able to duplicate with electromagnetic waves almost all the effects possible with light waves.

Let us examine Hertz's equipment in order to understand how, as early as 1887, he was able to produce radio waves. A spark coil like that in an automobile was connected to the two brass rods, as shown in the diagram. This apparatus was the transmitter of energy. The receiver was used to pick up the electromagnetic waves. When the receiver was tuned to the transmitter by using the correct length of antenna wires, Hertz found that whenever a spark was set up in the gap *ab* by the spark coil, a spark was received at gap *ef*. With this apparatus, simpler than the ignition system of an automobile, Hertz was able to establish the experimental foundations of radio communication.

An elementary explanation of the above experiment may be given in terms of electron movement. Whenever an electron is speeded up or changes its direction suddenly, it tends to radiate energy in the form of electromagnetic waves. If the oscillating motion of the electrons occurs at a frequency of 730 trillion times a second, then the electromagnetic disturbance will affect our eyes and be called light. If the frequency is in the range of 100,000 to 1,000,000,000 times per second, the energy radiated will be picked up by a properly tuned set as a radio wave. The chart at right shows how the nature of electromagnetic waves depends on the frequency of electronic oscillation. Since the frequencies are extremely high, mathematical shorthand is used in writing large numbers. Thus 10^{13} is 1 with 13 zeros following or 10,000,000,000,000. For convenience, this may readily be reduced

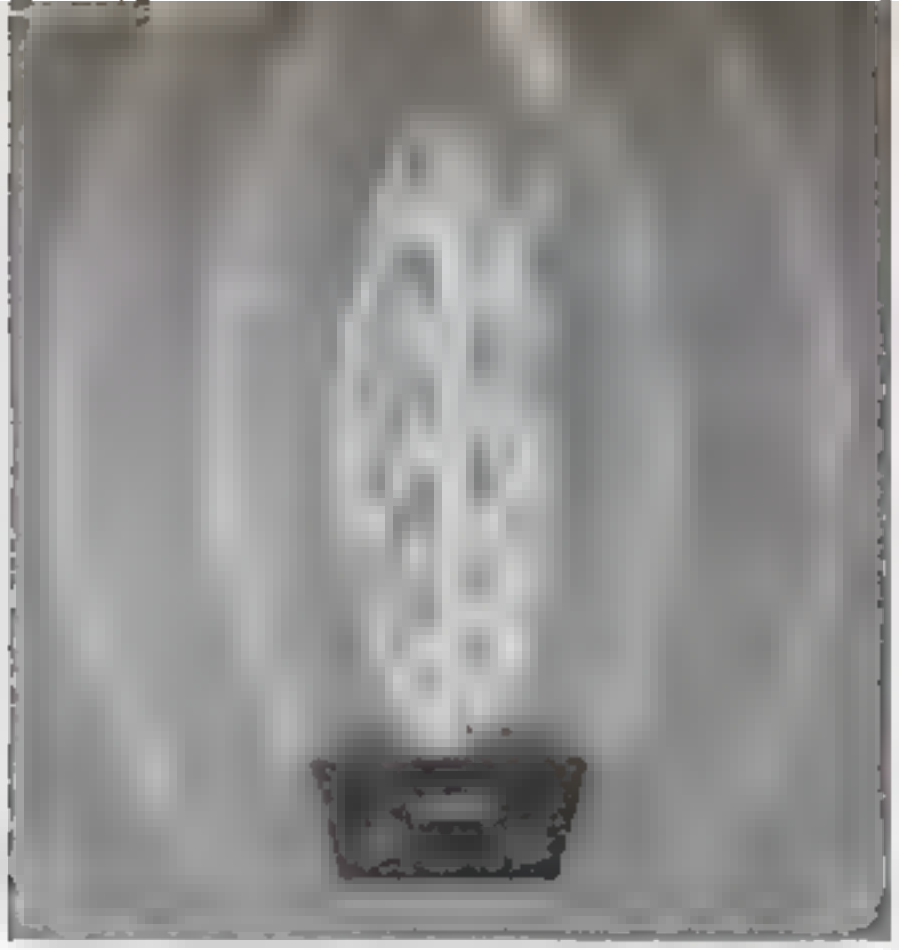


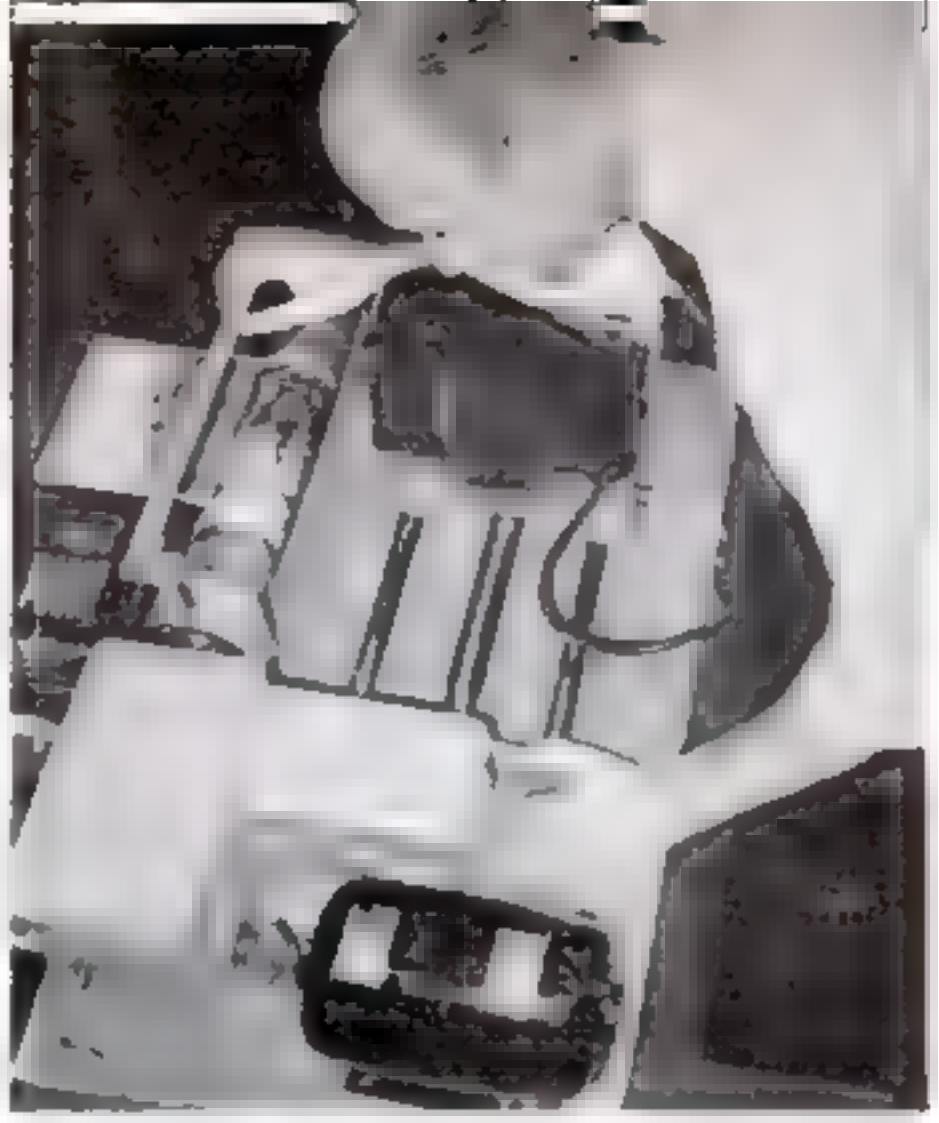
Modern version of the apparatus used by Hertz—a walkie-talkie radio that keeps Army patrols in close touch with their officers

to ten million megacycles. Directly above is a modern version of Hertz's apparatus. This walkie-talkie radio outfit used by soldiers keeps fast-moving patrols in constant touch with directing officers. A drawing on page HW52 shows graphically the mechanism of radiation.

An important phase in the development of electronics is the discovery of the photoelectric effect. In 1887, Hertz discovered that when ultraviolet light fell on the metallic knobs of the spark gap in his receiver, he could obtain a spark more easily.

A year later, Wilhelm Hallwachs, another physicist, studied the effect of light in producing a discharge from metal surfaces. As a result of





Electrons tend to radiate energy in the form of electromagnetic waves when speeded up or suddenly changed in direction. At right, transmission of pictures by radio—a new photo-cell application

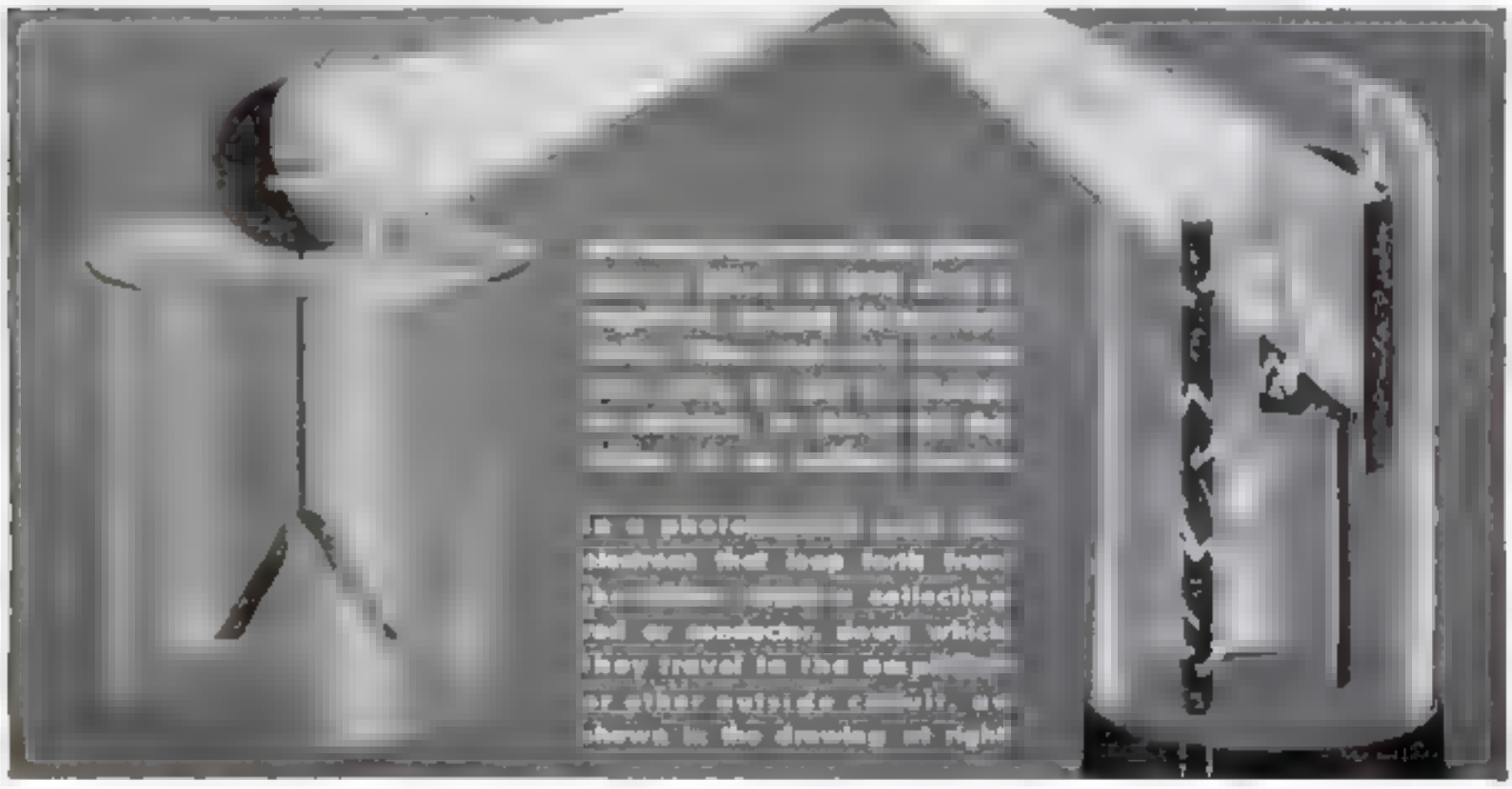
his work, he is credited with the discovery of the photoelectric effect. His apparatus is shown just below. Ultraviolet light falling on the zinc knob caused the leaves of the negatively charged electroscope to lose their charge of electrons and collapse.

Photo cells are today used to transmit television images, to help guard defense plants, to convert sound-track densities into talking movies, in plane de-icers, and in a vast array of other applications. One new use is the sending of photographs by radio.

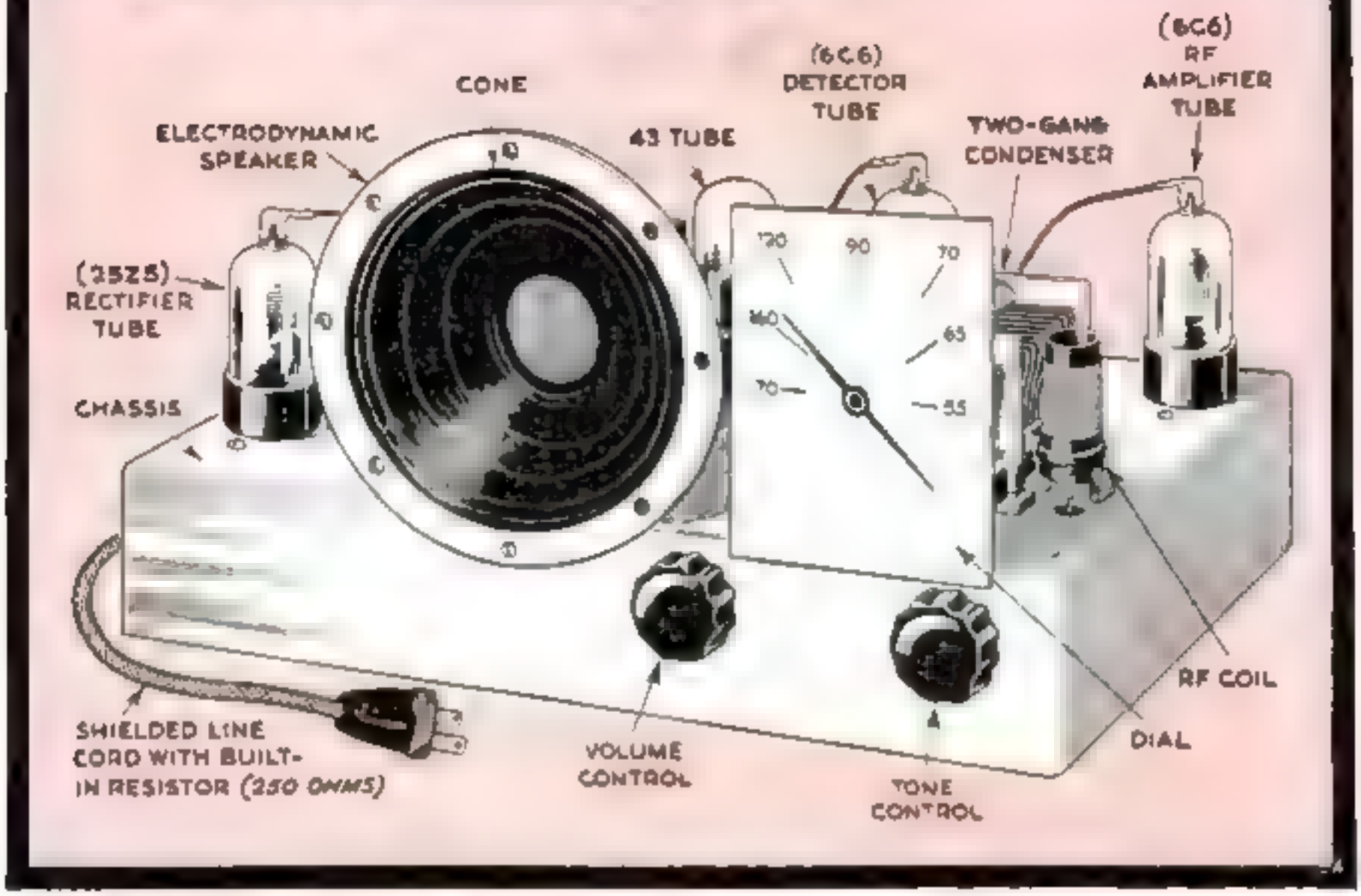
A diagram of the action of a photo cell is also shown below. The electrons emitted from the light-sensitive surface are picked up by the collecting rod and are conducted to an outside circuit. This stream of electrons constitutes an electric current.

The best way to learn electronics is to handle electronic equipment. However, due to the fact that almost all electrical equipment is being diverted to military channels, such apparatus will no longer be available to the experimenter. Fortunately, there is a source of equipment that most of us can tap at little or no cost. Every old or obsolete radio set is a veritable gold mine of parts. If you can get your hands on one that has outlived its usefulness, you can still make use of its components.

A few of the electronic devices that can be made from them are a radio-frequency oscillator, an audio-frequency oscillator, a wave-trap, and a phonograph amplifier. How to build these and other useful devices will be told in a later article.



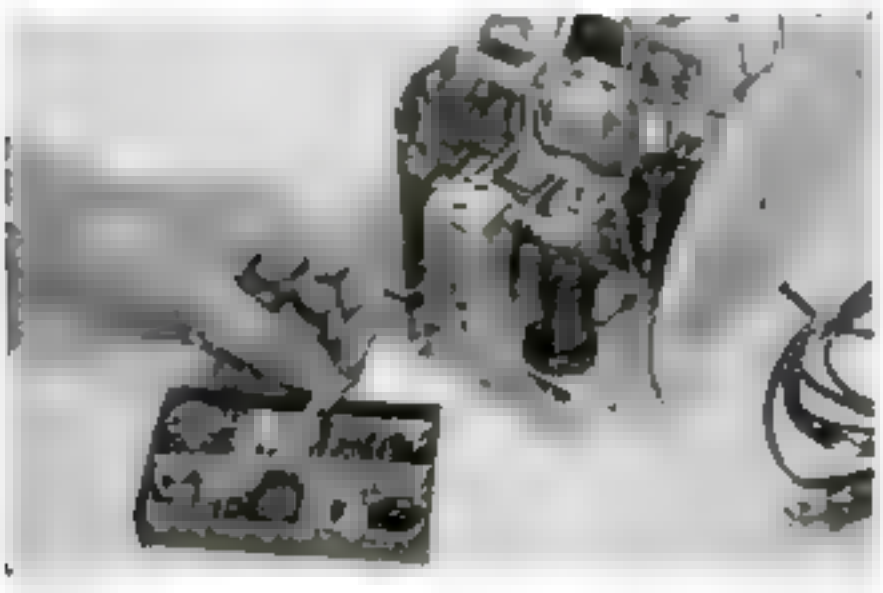
What's Wrong?



CAN YOU FIND EIGHT ERRORS?

How much do you know about radio? In the sketch of a four-tube A. C.-D. C. TRF receiver above, the artist has made eight intentional errors. Can you find them? As a clew, look for omissions and unnecessary inclusions, and study the parts themselves and their position on the chassis. Take as much time as you require; then turn this page upside down to check your answers.

ANSWERS: 1. A 6C6 is never used as an RF amplifier tube. In a four-tube TRF receiver, the first tube is always a 6D6 amplifier tube. The 6C6 is a control RF amplifier tube. 2. The RF coil is never mounted on top of the chassis; it is the antenna coil that is mounted in this position. The RF coil is mounted underneath the chassis for shielding purposes. 3. The 25Z5 rectifier tube should not have a grid cap on top of the bulb. 4. The resistance in the line cord is too high for the tubes used. It should be between 165 and 180 ohms. 5. Line cords on A. C.-D. C. sets are never shielded. 6. There is no dial-control knob shown. With only volume-control and tone-control knobs, there would be no way of selecting stations. 7. All the tubes have the wrong shape, since the 6D6, 6C6, 43, and 25Z5 types all have dome tops. The shapes in the sketch are those for the newer GT/G-type tubes. 8. The speaker is too close to the dial for practical use in a cabinet.



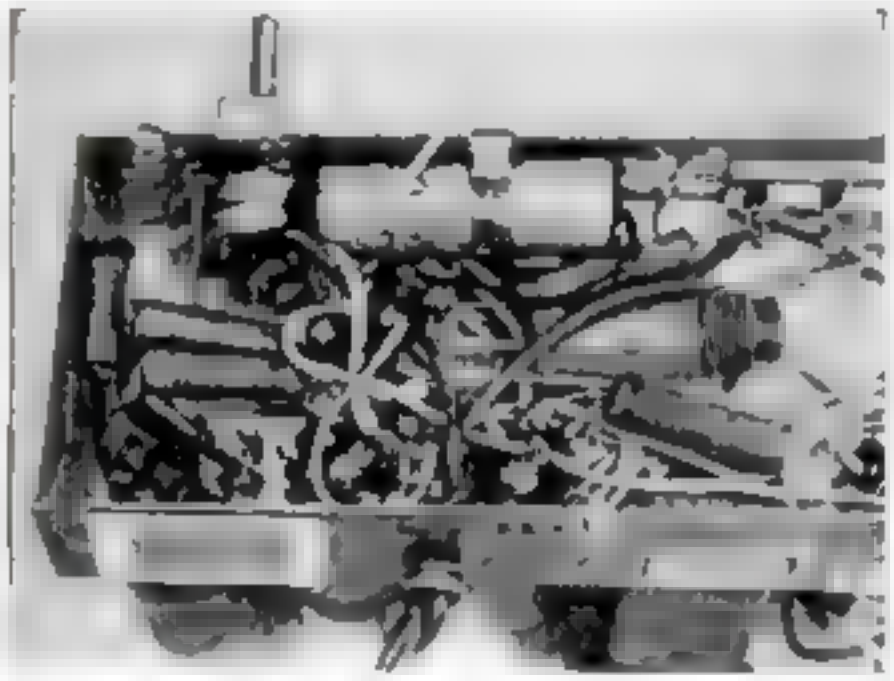
Pocket-Size Kit Contains Dial and Knob Parts

A COMPLETE assortment of knob springs, setscrews, dial pulleys, idler pulleys, and drive rubbers is contained in a radio kit, at left, equipped for repairing dials and knobs. The kit is convenient to take on jobs, since it measures only ⅞" by 2¾" by 4¾". Two models are available, one containing 70 pieces, the other 150, and replacements may be obtained. Either kit will service any type knob or dial.

Servicing Your Radio

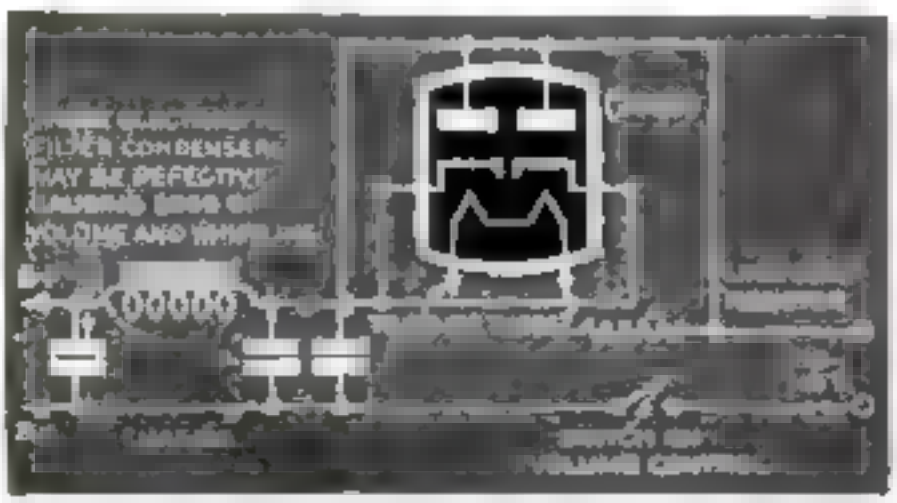
CHANGING PILOT LIGHTS is a simple operation in servicing a small A.C.-D.C. receiver, but be sure that you disconnect the radio at the wall socket—don't just turn off the switch. A serious short can occur if the pilot-light bracket and holder drop on the tuning condenser or chassis.

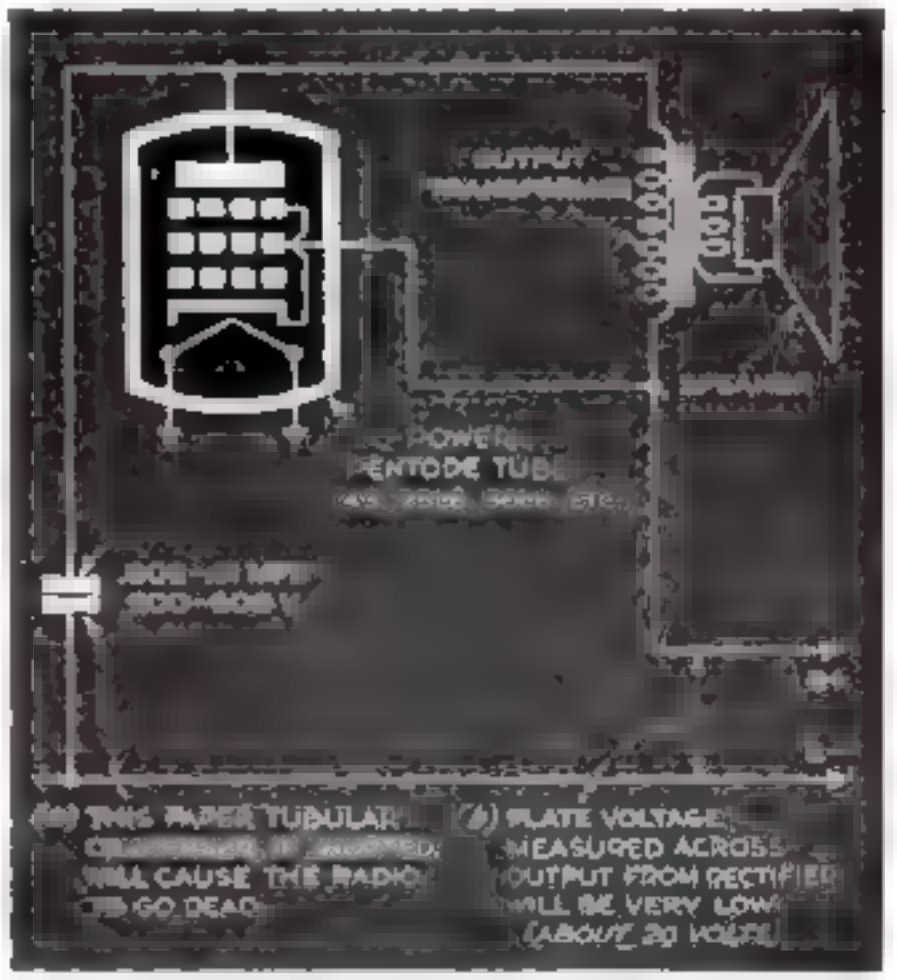
INCREASED HEATER VOLTAGE may be necessary if the rectifier tube burns out quickly on an A.C.-D.C. radio having a new high-voltage heater tube and no line-cord resistor. Try replacing the 35Z5-GT/G rectifier tube with a 45-volt rectifier, such as a 42Z5-GT/G, to increase the heater voltage to 120 volts.



SQUEALING AND WHISTLING that make it impossible to tune in a station clearly on a small A.C.-D.C. receiver may mean failure of one or both of the filter condensers shown in the photograph above and the diagram below. The noise is usually accompanied by a noticeable loss in volume. If defective, the condensers must be replaced.

THE PAPER TUBULAR CONDENSER connected between the power pentode tube and chassis, as shown in the diagram below, may be shorted if an A.C.-D.C. radio has gone dead except for the heater glow inside its tubes. This is especially true if, upon testing, the D.C. voltage to the tubes shows only about 20 volts. Remove the power pentode tube (a 43, 25L6, 50L6, or similar tube) from its socket, and test the condenser by placing an ohmmeter across it. If the needle on the meter swings over, the condenser is shorted and a new one must be installed.

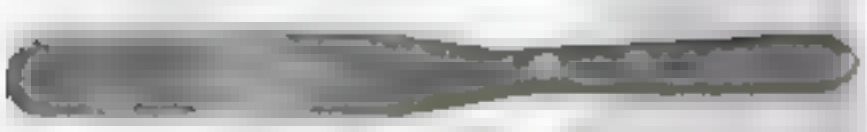




Question Bee

A SHARP shell or bit of flint was probably the first knife, so the origin of this tool undoubtedly dates from the dawn of human history. There is no tribe today, even among the most primitive peoples, that does not use knives of some kind. War, hunting, fishing, manufacturing, and the arts have all developed their special types, and at least seven different kinds of steel are used in the manufacture of modern knives. Can you name the ten common knives shown here? After writing your answers on the dotted lines, turn the page upside down to find your score.

1 .....



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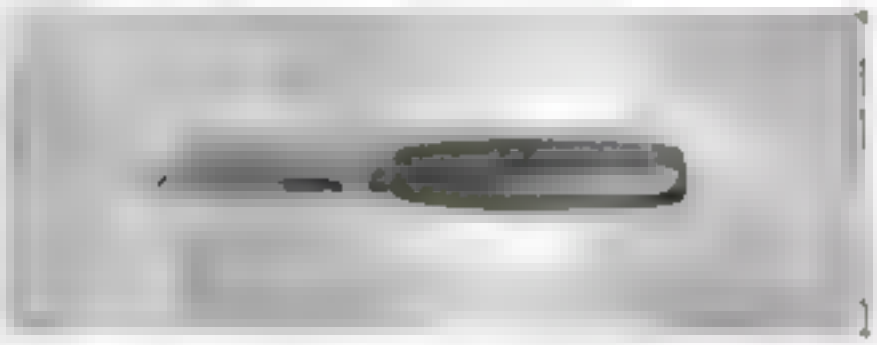

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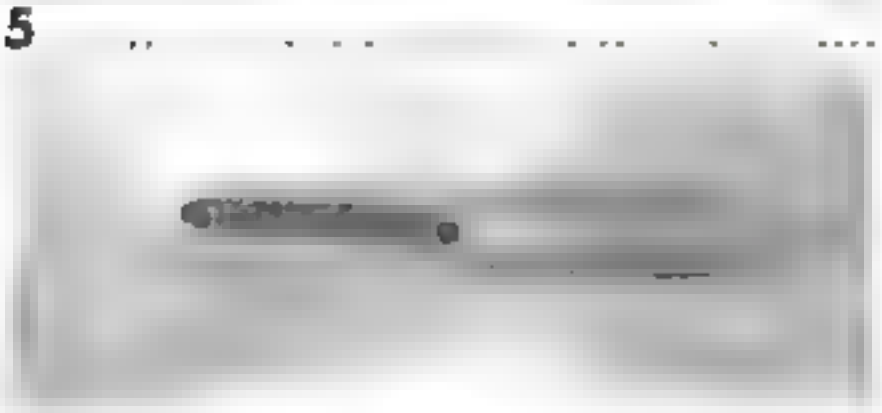
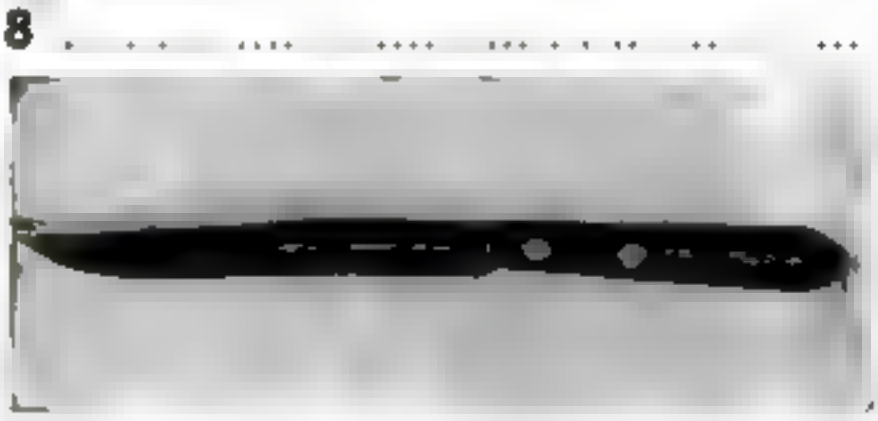


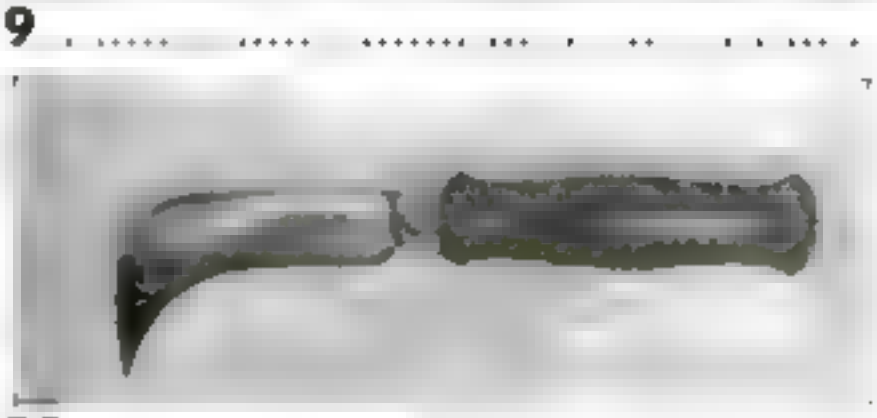
6 .....

7 .....

8 .....



9 .....



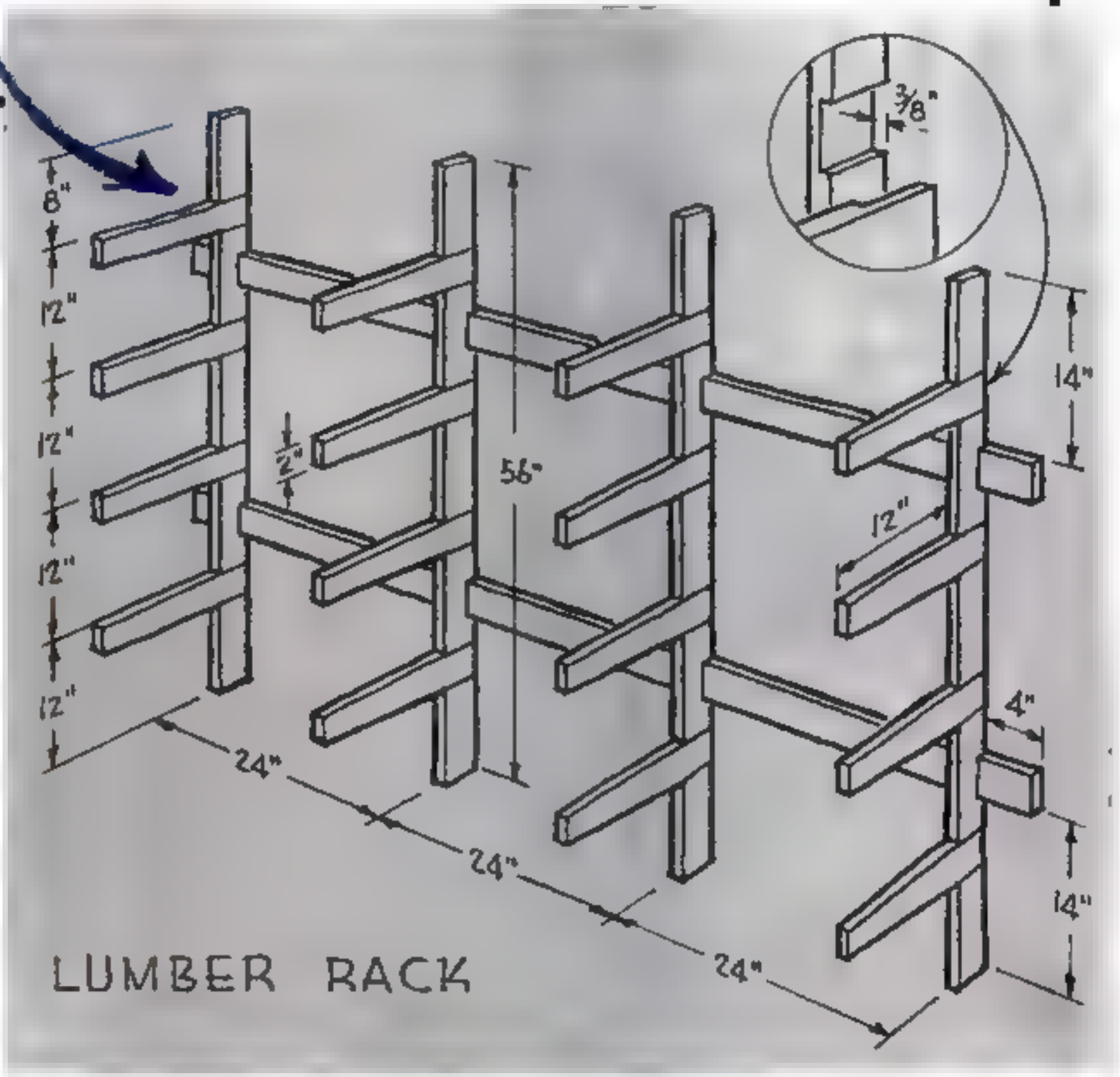
10 .....

ANSWERS

1. Grapefruit knife
2. Spatula
3. Sloyd manual-training knife
4. Sheath knife
5. Boe knife
6. Clam knife
7. Jackknife
8. Fisherman's knife
9. Slicing knife
10. Linoleum knife

Dear Workshop Editor:

Most home craftsmen need some kind of lumber rack badly. I know I do. Stock left on a damp floor is likely to warp or split, and if it's stacked up in a corner you may fall over it and you always have a hard time finding the piece you want. How about a plan for a simple rack that can be placed against one wall, with some way of keeping different kinds or thicknesses of stock separate? C.E.V.



Clear white pine ¾" by 3" is used for this rack designed by James N. Larson, but 4" stock would add strength, if desired. The four uprights are notched for lap joints with two cross supports and 16 lumber holders. These holders are alike, and can be made quickly on the bench saw by using a jig for cutting the bottom tapers. Assemble with nails, screws, or bolts, and mount on a wooden wall or, if the wall is concrete, make the uprights long enough to nail to overhead joists

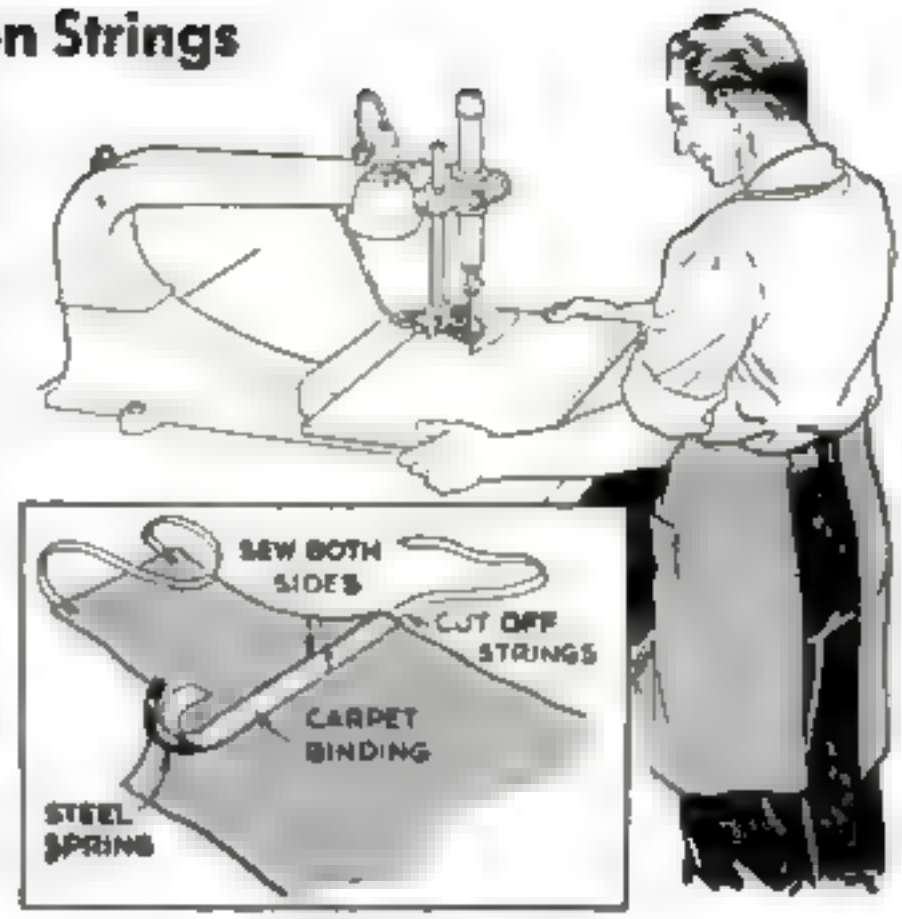
Clock Spring Replaces Shop-Apron Strings

AN OLD clock or phonograph spring sewn around the waist of your shop apron will eliminate bothersome strings and hold the apron firmly in place.

Cut the spring to a length equal to the width of the apron. It is wise to use the innermost part of the spring, since it has more tension, and will cling more closely to the body. Sew a strip of ordinary carpet binding across the apron with strong thread and insert the spring in the opening between the two rows of stitches.

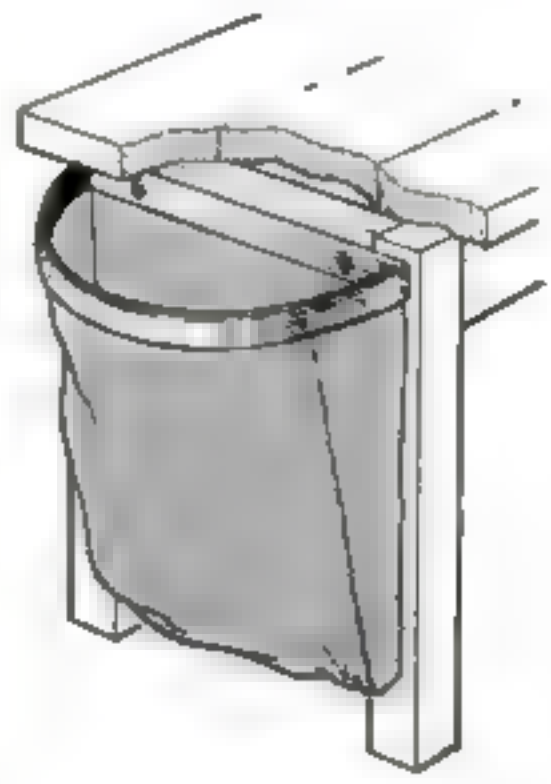
If you do not have a spring suitable for this purpose, you can purchase one for a small sum from almost any jewelry or clock-repair shop in your neighborhood.

When the apron is to be laundered, it is a simple matter to pull the spring out, and to replace it afterwards.—FRANK LAMBERT.



Detachable Bag Catches Litter from Workbench

A bag attached at the end of a workbench as shown below is useful for catching sawdust or shavings. A straight piece of wood as wide as the bench, with a curved piece of stock bent around it and screwed fast at each end, forms the bag frame. A burlap bag is fitted into this curve. Keyhole slots hook over screws so that the bag may be detached for emptying.—J. H. WILSON.

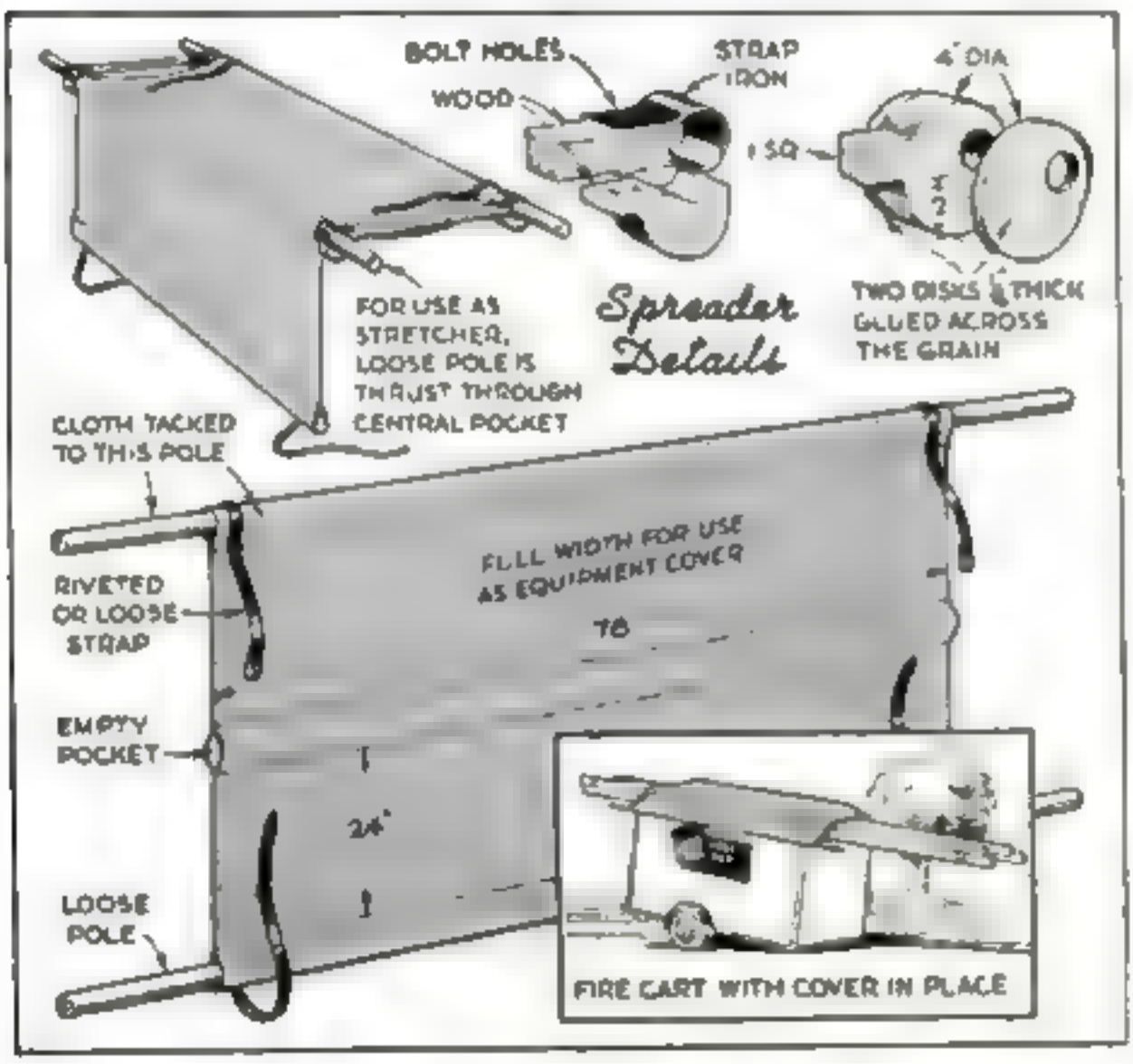


Stretcher Doubles as Cover for Fire Cart

HEAVY, unbleached muslin—waterproofed and cut out to cover civilian-defense equipment, such as a mobile fire cart—can also serve as an emergency stretcher.

If the cover is wider than a standard 27" stretcher, a third pole pocket should be stitched in. The length of the stretcher fabric should be approximately 78", and the poles should protrude far enough at both ends for an easy carrying grip.

Two alternative spreaders are shown in the drawing, one built entirely of wood. Straps will be needed for fastenings when the unit is used as a tarpaulin.—BLAINE KLUM.



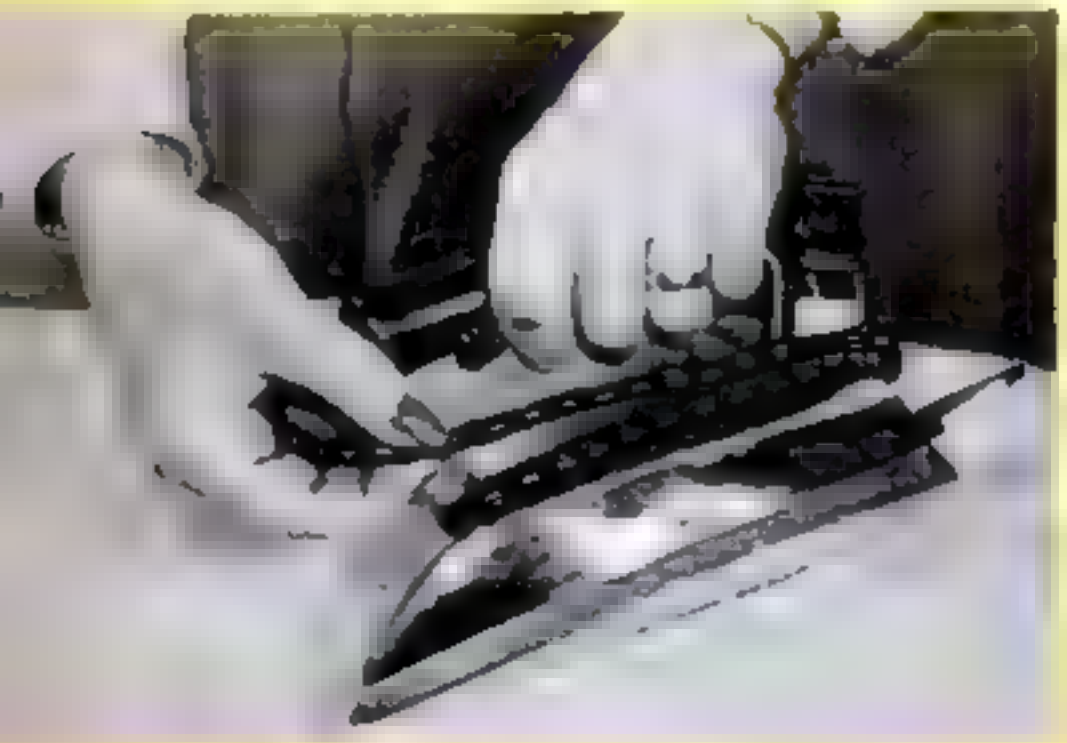
AIDS TO WARTIME *Housekeeping*

PROLONGING THE LIFE OF YOUR IRON

IF YOUR iron sticks to the clothes, starch or other foreign material has probably collected on the sole plate. Remove this by rubbing the hot iron on a piece of paper sprinkled with salt, as shown above. The metal surface should then be waxed by rubbing it with beeswax or paraffin

The sole plate must be smooth for easy ironing. Don't scratch it by ironing over buttons, snaps, zippers, and the like.

Never kink the cord. Avoid coiling it around the iron while the latter is hot Detachable cords should be removed and hung up separately.



ALL-GLASS PRESERVING JAR This has a reclaimed-rubber gasket that can be used again and again. The jar is opened by indenting the gasket with a sharp instrument through a special slot in the side

TESTED RECIPES are contained in this file, which has index dials for locating the cards quickly. Each of the 22 sections, from appetizers to desserts, is tabbed. Touch one of the tabs and a dial pops up to tell you all the recipes in that section

A FURNITURE POLISH for general use on varnish, shellac, or lacquer finishes removes spots and covers minor scratches. A cloth is moistened with the polish, applied to the spot, and rubbed with the grain. Removes liquor, water, and even heat marks

PREPARING CORN DISHES, such as corn fritters, succotash, creamed corn, and the like, is made easy by this stainless-steel scraper with specially designed teeth that split the kernels and cut them off the cob in one motion, leaving only the hulls. The wooden handle is enameled green or red to match other utensils

COOKING ODORS are dispelled with an air purifier that can be attached to any fan. The unit clamps upon the guard of the fan, and a wick arrangement dispenses the liquid inside the bottle onto a fibrous pad from which it is volatilized into the room. Feed can be altered by varying the number of wicks in the bottle

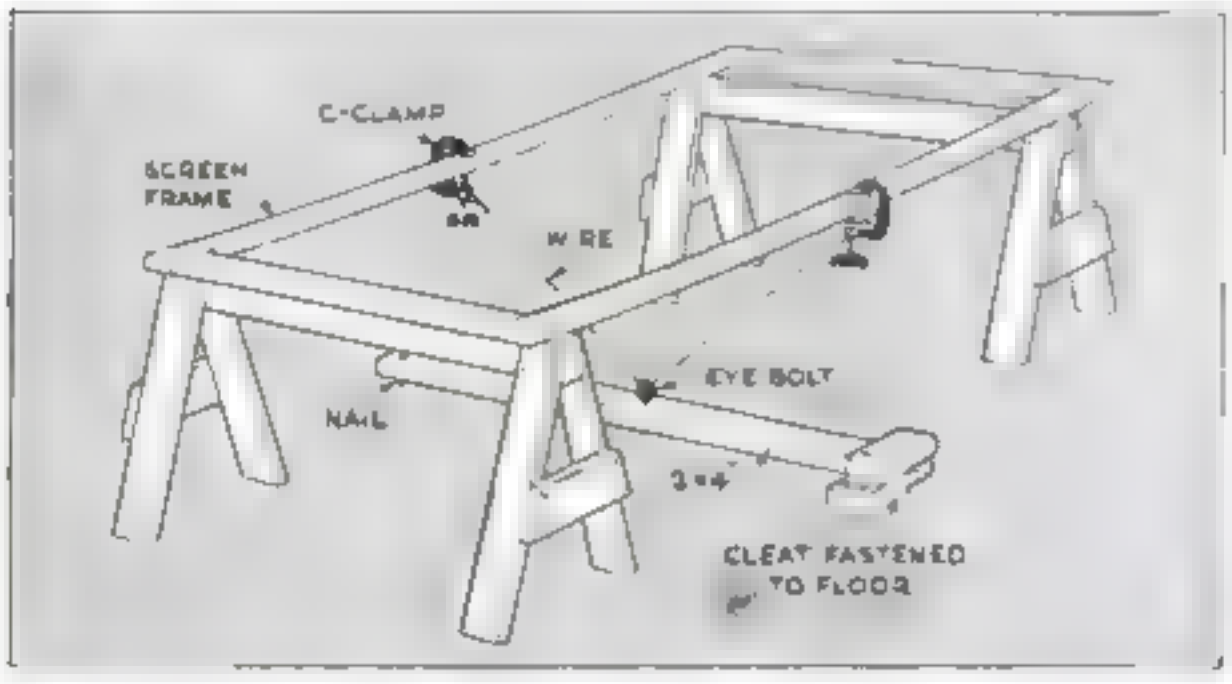
OFFICERS' BUNK BAGS provide ample space for two uniforms (or uniform and overcoat), plus all other essential clothing and military accessories. The garments travel on hangers, shown above, inside cellulose-film envelopes. The bags are covered with water-repellent sailcloth in olive drab or navy blue

EXTRUDED PLASTIC takes the place of rubber in this kink-preventing jacket, which is easily placed on any ordinary telephone cord. Translucent and lighter than rubber, the spiral jacket is already coiled and will retain its shape for an indefinite time

GENUINE SPONGE is sewn inside the soft tufted sack shown above, creating a very absorbent cleaning sponge for all household purposes. It will not scratch or shrink, and dries to a thick, fluffy pile. The sponges are available in three useful sizes

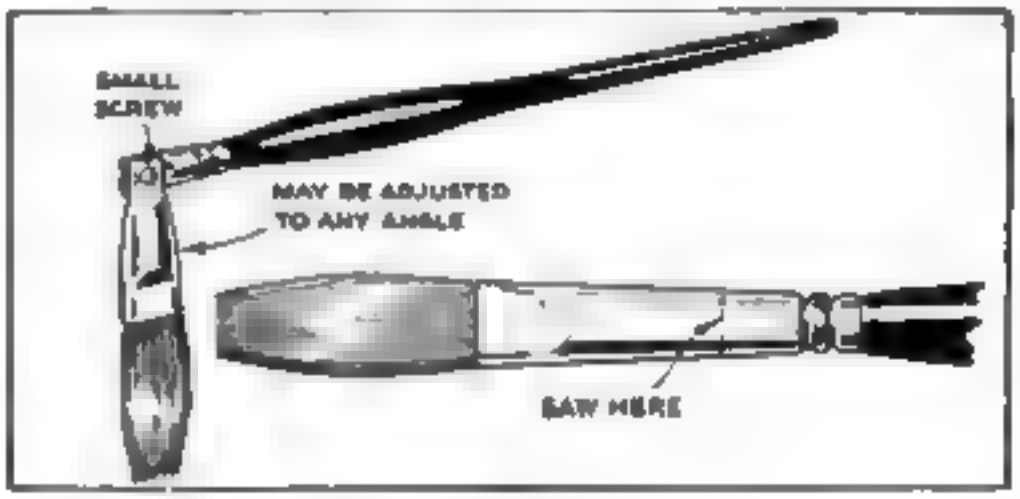
Frame Is Bowed at Center to Pull Wire Screening Taut

WIRE screening can be made taut by bowing the frame ⅛" or so at the center while the ends of the screening are being tacked on. Place the ends of the frame on sawhorses, and fasten a C-clamp at the center of each side. Lay a sturdy board under the clamps, nail one end to the floor, and attach an eyebolt to the board midway between the two clamps. Through this eyebolt and the clamps stretch a wire or cord, fastening it so that the free end of the board is about 2" off the floor. Then press the board down, working it under a cleat, as indicated in the drawing. This will bow the frame sufficiently for the screening to be attached to the ends. Release the tension on the frame when you wish to tack the sides down.—E. M. WOODEN.

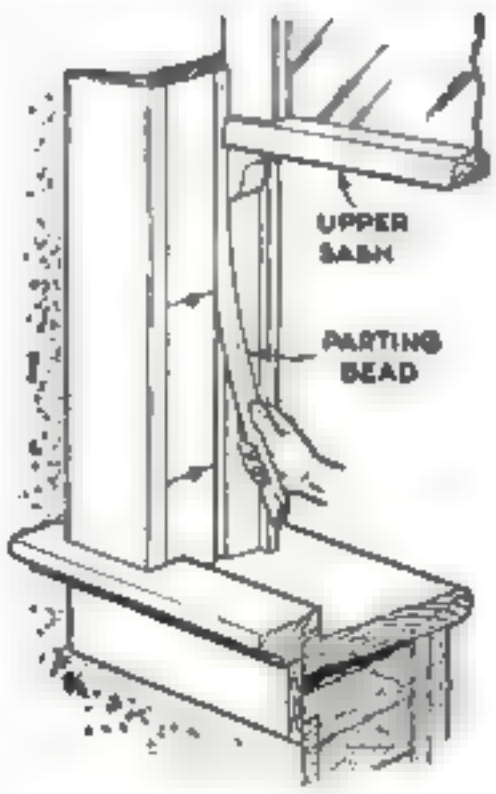


Angle-Painting Problems Solved with Adjustable Brush

HERE'S an adjustable-angle brush for painting inaccessible corners on cameras, recording instruments, and similar equipment. Saw off an ordinary brush about two thirds of the way up the ferrule. Drill corresponding holes in the metal ends, and join the two parts with a machine screw and nut, as shown. Set at the most convenient angle, and tighten the nut.—CHARLES HOMEWOOD.



REMOVING UPPER WINDOW SASH [SHIPSHAPE HOME]



Upper sash cords do not often need replacement, but when they do, a stop must first be removed and the lower sash taken out and laid aside. Then pry out the parting bead from the same pulley stile. This member, sunk in a groove, is often held by a nail near the center, and if the runs are painted, may be stuck tight. Drive the edge of a wide chisel into the bead at various points from behind, raising or lowering the sash as required, and pry against the bevel until the parting bead is loose. A knife point passed along each side may help.

Raise the sash to the top and pull the strip out of the groove, twisting it forward to clear the notch in the end of the check rail. It may be easier to lower the sash and pull out the bead from above. Replace the sash cord, swing the sash into place, and put back the parting bead. Rehang the lower sash and install the stop.

POPULAR SCIENCE MONTHLY SHOP DATA

Sabotage Under Your Roof

HOW CONDENSATION CAUSES A HOUSE TO DETERIORATE . . . AND WHAT YOU CAN DO TO CORRECT IT

IN THOUSANDS of loyal American homes, sabotage is going on. This sabotage is unintentional, but scarcely less severe than if it were enemy inspired. When paint blisters and peels or brown stain appears on the outside walls of a new home—look for sabotage.

People who pride themselves on maintaining healthful living conditions are most apt to be unwitting partners to the crime. For the offender—the saboteur—is condensation or uncontrolled moisture in the home. Like a stealthy enemy agent, it performs its destructive work unsuspected and unseen.

Ironically enough, condensation rarely gets the blame. If the paint has failed, we sue the painter. If the woodwork is stained, we blame the carpenter. The surface evidence is against them, and they have to make good the damage. Yet underneath, the true culprit, condensation, goes unrecognized and is left free to raise havoc again.

Condensation is a national problem. So prevalent has it become in recent years that many scientific building authorities have delved into the subject, among them the National Bureau of Standards, Forest Products Laboratories, the University of Minnesota, Iowa State College, and the Canadian National Research Laboratories. They all agree on a common cause and a common cure.

Back in grandfather's day, homes were drafty. In winter you could feel the chill wind blowing in around the doors and windows, and the walls were cold to the touch. Escaping heat melted snow on the roof almost as soon as it fell. Just as the cold air crept in and the heat escaped, moist indoor air easily found its way outdoors. Grandfather had a serious fuel problem, but no paint troubles worth mentioning.

His grandsons live in much more comfortable homes. Heat loss and wind infiltration have been reduced by insulation, weatherstripping, storm sash, and tighter construction. Cracks and crannies through which moist indoor air might escape have been largely eliminated. For health and comfort, modern homes are often provided with furnace humidifiers or some other means of increasing indoor humidity. It is

Introducing:

The little man who WAS there—if things happened when they shouldn't. He's the Household Gremlin, grounded cousin of the sky piry who's the bane of air pilots. How he loves mischief!

in these homes where high humidities are maintained that most condensation difficulties occur. And the grandsons have paint trouble aplenty.

What is condensation? When water is evaporated, it changes into an invisible gas or vapor which mixes readily with air. This water vapor in the atmosphere we call humidity. As a gas, water vapor exerts a definite pressure that is part of the total pressure exerted by the atmosphere. Vapor, therefore, tends to expand to areas where the pressure is less, much as gas leaking from a kitchen stove will quickly spread throughout the house and force its way outdoors.

The amount of vapor that the air can carry increases as the temperature rises, and decreases as the temperature drops. When vapor-laden air is for any reason cooled—by striking a cold surface, for example—it can no longer retain the moisture it has taken up, and what we call condensation sets in.

In our homes we are seldom aware of water vapor until condensation has set in. A vast quantity of it is drawn into the air

VITAL SPOTS IN YOUR HOME WHERE CONDENSATION CAN CAUSE

from new plaster, furnace humidifiers, air-conditioning equipment, and rooms where heated water is in use—the bathroom, laundry, and kitchen. The air exhaled from our lungs and moisture evaporated from our skin surfaces contribute more air-borne moisture.

Acting under pressure, this vapor moves as a rule from warm to cooler areas entirely independent of air currents. It passes readily through plaster and other unprotected wall coverings on its way to the outside air. Gathering in the stud spaces within the wall and cooling there, the vapor condenses into water, and destructive action begins. The moisture works through the sheathing and siding to the paint film, where it forms blisters and causes the paint to peel.

Certain woods commonly used for siding contain large percentages of water-soluble coloring matter. Moisture passing through the siding from within leaches out this coloring matter and deposits it on the painted exterior in dirty brown streaks resembling tobacco juice. If used promptly, a solution of one half painters' alcohol and one half water will remove the ugly stain, but if the stain has become oxidized the surface must be scraped and repainted.

COSTLY DAMAGE

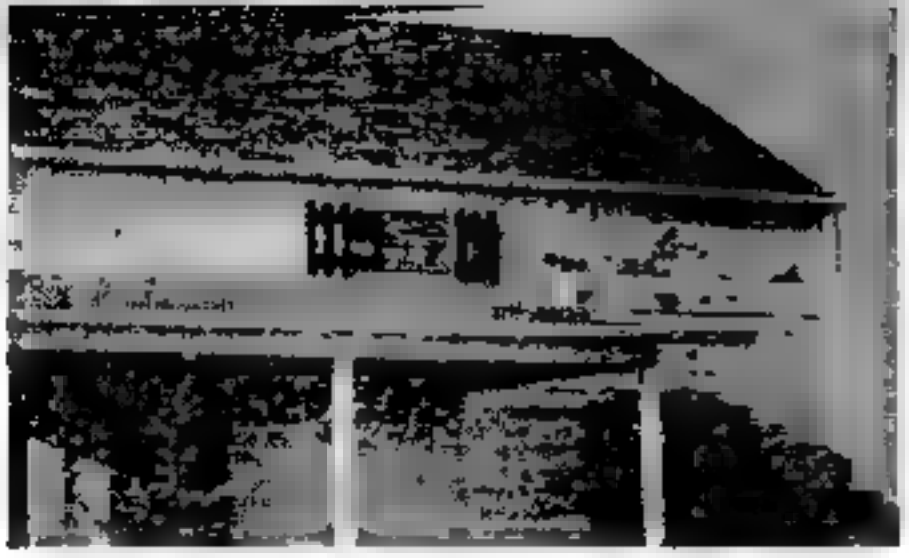
Lumber used in homes normally contains from 12 to 20 percent moisture. When condensation water soaks into the wood and forces the moisture content above that range, there is bound to be trouble. The wood will swell and warp or even split. Doors and windows will stick. Excessive moisture working through the siding may encourage dormant fungus spores to develop in the wood and discolor the paint film with a dirty blue stain.

In homes of brick or stone, moisture from within, after freezing a few times, may break the mortar bond, leaving little but gravity to hold the masonry together. As moisture passes through the wall, it leaches out alkali salts, which on evaporation are left on the surface as a disfiguring white deposit known as efflorescence.

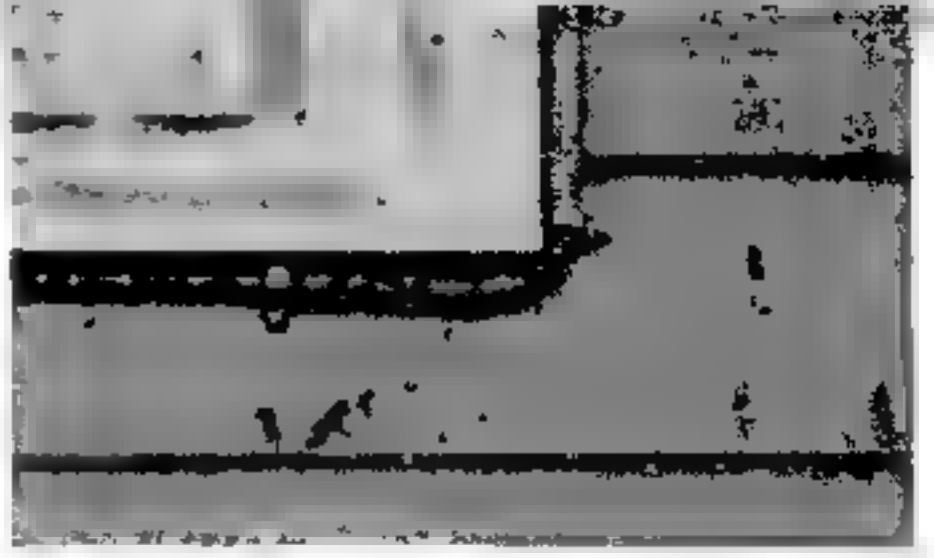
Moisture condensed in the walls may also do considerable damage to home interiors by soaking through the plaster and discoloring the wallpaper. High humidity invites decay in wood, permits corrosion of metals. In warm weather moisture condensing on cold-water pipes may drip on the woodwork and cause serious localized decay. In winter there may be so much condensation on window panes that water will run down over the sash or sills and soak into the wood.

Now, what can be done? Authorities agree that the relative humidity in homes should be controlled according to the outside temperature. In below-zero weather the indoor relative humidity should not be more than 20 percent; between zero and 20 deg. F., not more than 30 percent, and in temperatures over 20 deg., not more than 40 percent.

Lowering the relative humidity indoors as the outside temperature drops may be accomplished with exhaust



The owner of this new home bragged about the high humidity he maintained—and look what happened. Condensation is the cause of many paint failures



Four types of paint deterioration near a bathroom window—peeling on the casing, blue stain on the sash, and brown stain and blisters on the siding

fans, and ventilating louvers may be installed to assure frequent changes of air. When moisture gathers on walls, windows, or mirrors in the kitchen, laundry, or bathroom, open the windows and let the saturated air escape. Regulate the furnace humidifier or shut it off entirely in below-zero weather.

These precautions, although helpful, are not sufficient. The outside walls and top-floor ceilings are still permeable to vapor. The problem is, therefore, (1) to stop the vapor from entering the outside wall and top-floor ceiling spaces, and (2) to allow any vapor within these spaces to escape outdoors. In other words, a "vapor dam" is needed on the warm side of the outside walls or top-floor ceiling to retard vapor travel, and a "vapor gate" on the cold side to carry off any overflow from the "dam."

In new construction this is easily accomplished by installing an asphalt vapor barrier underneath the plaster, and by avoiding the use of any materials in the outside part of the wall which too greatly retard the escape of vapor. For homes already completed, two coats of a good oil or varnish-vehicle paint on the interior of all outside walls and top-floor ceilings will provide an effective vapor barrier. There must be no gaps. Protect the backs of cupboards and bins in the kitchen, bookcases and window seats in the living room, cabinets and buffets in the dining room, and all other built-in features, and don't forget the closets or the area underneath and behind the bathtub where it adjoins an outside wall. Above all, make sure that no vapor can escape from the basement into the stud spaces. Here a reinforced duplex building paper will provide an excellent vapor seal. Remember that any appreciable gap in the vapor barrier may result in condensation trouble.

Moisture difficulties may arise from other sources. Moisture may enter the wall through improper flashing at interior angles, eaves, or over doors and windows, and it may also seep in through cracks or gaps in the siding. Look for loose joints at the corners of the house, around door and window openings, and between the boards themselves. Any good caulking will correct this.

Excessive moisture in the basement may be due to ground water or unusually damp surrounding areas, such as those caused by heavy shrubbery planted close to the house. Slope the soil up to the foundation so that water will drain away from the house, and make sure there are no low spots near the wall where water can gather.

If trouble persists, it may be necessary to dig a trench around the house and lay drain tile next to the foundation and just below the basement floor level. Before filling in, give the foundation wall a good coating of asphalt. Check downspouts and leaders for breaks below the ground level.

For slow leaks in foundation walls, any good concrete waterproofing compound applied on the inside should prove a corrective.

Natural gas, when burned in open heaters, produces a vast amount of water vapor. During a single heating season a five- or six-room home—for example, one in Oklahoma City, Okla., where much natural gas is used—may burn 80,000 cubic feet of gas, and in the process some 800 gallons of vapor will be released, with possibilities of condensation damage. To prevent condensation, gas heaters should be vented directly to the outside so that the water vapor produced in combustion will not be added to the air in the house.

Chimney failures from disintegrating mortar may be due to moisture caused by poor capping or originating within the flue. In converting a heating plant from coal to gas, reduce the diameter of the flue to 5" or 6", or the extra moisture from gas combustion will be chilled to the dew point before escaping. An acid- and corrosion-resisting slip-in liner should also be inserted in the flue.

CHAMPION SPARK PLUGS are the

dependable source of full, flowing engine performance, so vital to a Navy pilot at that crucial moment when an enemy ship—the never-to-be-forgotten prize—looms large in his sights. Champions are on active duty on every front.

The furious assault on an enemy ship by a formation of Navy dive bombers is a magnificently awe-inspiring and intense moment. Already the record books are replete with glorious achievements on the part of the men who man these avengers of Pearl Harbor. The records likewise show that many of these Navy planes, as well as all other types of planes in use by our air forces, are powered by engines equipped with Champion Spark Plugs. In performing their vital tasks, instantaneous response to the throttle is paramount and depends on the proper functioning of the all-important spark plugs. The characteristic dependability of all Champions, including those for your car, is directly due to research, engineering and precision manufacturing unequaled in the spark plug industry.

Polarized Light

(Continued from page 61)

tion for 30 seconds to two minutes, the relief images absorb it like sponges.

Watch closely—you are about to see some chemical sleight of hand. Between the two leaves of the book, the operator has slipped a blank sheet of transparent plastic. Hinge first, the sandwich zips through a pair of wringer rolls. A minute later, the relief prints are stripped off; they can be used again many times. There remains the transparent sheet, now bearing a faint image on each face. Look at it through a pair of polarizing spectacles—and a brilliant stereoscopic view fairly leaps out of the film.

What has happened? Like tricks of stage magic, it will take a bit of explaining. In the first place, that sheet of transparent plastic wasn't as simple as it looked. To make it the opposite faces had been so treated that their molecules were aligned like the letter "X"—diagonally and at right angles to each other. At this point both faces possessed a curious property. The molecular surfaces did not yet have any polarizing power for light. But each surface could be made polarizing, in the direction of its molecules' alignment, by a suitable chemical reagent. And the degree of polarization would depend upon the quantity of the reagent absorbed.

Now the mystery is clearing up. The brown liquid soaked up by the relief prints was the reagent that made the sheet polarizing. And the effect was proportional to the amount of liquid transferred to the plastic film. The degree of polarization was strong, medium, or weak, depending on the relative height of different parts of the relief prints, which in turn determined the amount of reagent soaked up and transferred. Lenses of the viewing spectacles, also set with their angles of polarization diagonal and apposite, acted as optical valves—letting through the light portions, partially shutting off the halftones, and "blacking out" the dark portions of the image intended for each eye.

For color stills or movies, the problem was a stiffer one. It called for reagents that not only made the film polarizing, but also imparted the proper colors — blue-green, magenta, and yellow. Since left- and right-eye images are required in each color, a full-color film consists of six images.

For an opaque "reflection print," the back of a Vectograph is brushed with a mirrorlike aluminum pigment. Transparencies get lacquer on both sides. For a lantern slide, the Vectograph is simply bound between cover glasses.

but here is one worry you can avoid

UNCLE SAM needs YOU in your war-job . . . whatever it may be. Equally important, he needs you on the job *all* day, *every* day.

That means you've got to keep your *car* on the job too . . . ready to get you to work on schedule! So stop car troubles *before* they start. Avoid excess chassis wear with Marfak lubrication.

Marfak helps add miles to your car's life by *cushioning* king pins, tie rods, drag links and other vital friction points. Marfak especially resists the washing-out effect of snow, slush and rain. It's super-tough. It "stays put."

To insure *worry-free* protection, Marfak is applied by chart, not by chance!

Never say "grease-job." Insist on genuine Marfak 40-point Lubrication Service. At Texaco and other good dealers everywhere.

For Your Enjoyment . . . 2 Great Radio Programs

FRED ALLEN: On the air every Sunday night, Columbia Network.

METROPOLITAN OPERA Complete broadcasts of great operas every Saturday afternoon. Blue Network.

You're Welcome at **TEXACO DEALERS**

Cheating Axis Torpedoes

(Continued from page 89)

from the ship. Then the lifeboatman in charge makes a thorough inspection of the boat. Once he has ascertained that it is seaworthy—in an actual sinking he would have to supervise the plugging of all holes caused by machine-gun strafing or any other mishap of battle—he checks all provisions, distributes his men to the various watches, and assigns duties to the whole crew. He then appoints his next in command and confers with them, studying the pilot chart to determine the most suitable point of land to head for.

When all these preparations have been made and a course charted, the log must be written up and orders given. Now the routine life begins, and a tough life it is, as taught by the Academy instructors. Cadets learn that they must at all times maintain the strictest discipline to bolster flagging spirits—every man must be constantly occupied, for idle minds are prey to fear and despair. No smoking is allowed on lookout, and talk is cut down to a reasonable minimum; a man with his eyes peeled for a passing ship or plane, or for land, must not be distracted from his job. Most ticklish task of all, and the most exacting, is to figure out the rationing of provisions. This depends partly on climatic conditions: more water is needed in the tropics; less water and more hard provisions to provide body warmth in northern latitudes. For the rest, the time period over which supplies must last is cautiously estimated by doubling the number of days it will take to reach the nearest point of land under favorable prevailing winds.

One of the commander's first duties is to call in all personal supplies before the rationing system is laid down. This rule is nowhere so essential as in the control of cigarettes. Smoking not only keeps a man's spirits on even keel in the grimmest of circumstances—it also cuts down his appetite appreciably, and thus makes emergency rations go that much farther. Archie Gibbs, twice-torpedoed deck hand who spent four days as a prisoner aboard a German sub, says "guys have been lost when they stood up in the boat, said they were going to mosey across the street for a smoke, and stepped over the side."

By the time the war comes to an end, ours will be a merchant marine of seasoned men, for the Government is doing everything possible to make sure that men now going to sea in American ships will be back to finish the job.

$1,000 FOR YOUR IDEAS In the Big Marlin Gun Contest!

Now here's a chance for you hunters and target shooting fans, to *cash in* on your knowledge of guns! Marlin—always on the lookout for new ideas to improve sporting firearms—wants to hear from you. Sportsmen and gun dealers are cordially invited to join Marlin's big Gun Contest—with $1,000 in cash prizes to shoot at. And remember, many a good idea is simple and easy to describe. Your chance is as good as the next fellow's to win a prize. It's easy to get in the contest—read the details below and send your entry in today! Contest ends July 1, 1943.

Jot down your ideas for improving any current model Marlin Gun. Follow the simple contest rules and send your entry in. If you wish, you may suggest new features, not at present in the line. A free catalog is yours for the asking, to review the features of Marlin Guns.

PRIZES IN THE BIG MARLIN CONTEST

The first prize is $500.00 in cash; second prize $100; third prize $50.00; fourteen additional prizes of $25.00 cash each. Seventeen prizes in all! (Marlin suggests the purchase of U.S. Savings Bonds with the prize money.)

JUDGING

Three famous gun editors—Bob Nichols of Field & Stream, Jack O'Connor of Outdoor Life, Maj. Chas. Askins of Sports Afield—will select the winning entries. All ideas for which prizes are given become the property of The Marlin Firearms Company and none will be returned. Prizes awarded for the seventeen ideas which are most valuable and practical, in the opinion of the judges. Duplicate prizes awarded in the event of a tie. WINNERS will be determined and prizes announced as soon as possible.

CONTEST RULES

The Marlin Gun Contest is open to all sportsmen and dealers in guns, with the exception of Marlin employees. Written suggestions must not exceed 300 words, the shorter the better. No limit to number of entries which may be submitted. Write name and address clearly on each suggestion. Mail entries to Dept. K, The Marlin Firearms Co., 17 E. 42nd St., New York City.

Entries must be received on or before July 1, 1943.

Win cash with your ideas! Enter the Marlin Contest today.

The Marlin Firearms plant is now 100% on war production.

Marlin's Over & Under Shotgun, in 12, 16 and 20 gauges and .410 bore, is hammerless, cocks on opening, has sturdy one-piece frame.

All Marlin rifles—lever action, clip and tubular magazine and .22 automatic, feature deep-cut, accurate, "Ballard" rifling.

Marlin lever action rifles, in calibers .22, .30-30 and .32 spec., have the solid-top, case-hardened receiver, with safe side ejection.

Studios on the Battlefield

(Continued from page 113)

officers' uniforms, minus all insignia except an identifying brassard. But in action they share the dangers of both officers and enlisted men. It is remarkable that only a few have been on the casualty lists.

Five newsreel companies—Fox Movietone, Pathe, Paramount, Hearst's "News of the Day," and Universal—comprise the Newsreel War Pool. Each has two cameramen on the fronts of the world, with others available if and when Washington opens new pool areas.

All newsreel and still-picture films are subject to stiff censorship regulations, the authorities here and abroad keeping a sharp eye out for anything that might give aid or comfort to the enemy. The usual procedure in the case of stills is for censorship to begin with the military or naval commander in the field, thence to the fleet or zone commander and then to Washington. Newsreels generally are sent directly to Washington for review.

Hitler may have been the first to employ films as a weapon of war, but our own military leaders have made up for lost time. Special training schools have been established to prepare cameramen and photographers for the fighting fronts.

One of the most ambitious Army projects has been the establishment under the Signal Corps of new self-contained, mobile photo assignment units, with cameramen, photographers, laboratory men, and assistants equipped to record front-line action. From their welded platform atop an Army carryall cameramen, protected by the Tommy gun of their driver, grind out scenes of battle of utmost importance to the military leaders—and of absorbing interest to the public when permitted by the censors to supplement the films in the war pools.

The Navy, too, has realized the benefits derived from newsreels and photographs of actual combat. Some of the most striking pictures to come out of the war zones are the work of Navy lensmen. To expedite the training of naval cameramen, the newsreel companies have opened their doors to Navy men, sharing with them their professional secrets and experience. The classes are held at race tracks and fires, ship launchings and weddings. The idea is to give the Navy men practical experience by having them accompany a professional cameraman on regular news assignments and film the same events that he does. The newsreel producer compares the films and sends a critique to the Navy Department.

Why Our Tanks Are Best

(Continued from page 125)

model, called a combat car, weighed a ton less and had a single turret. Both models were armed with .50 caliber and .30 caliber machine guns.

Our Ordnance officers were convinced that the M2A3 was the best light tank in the world. Events soon proved that they were right. In the spring of 1938 the German Army—by then the acknowledged leader in mechanization—invaded Austria without having to do any fighting. Mechanical failures on the road made casualties of seven percent of its tanks. A few weeks later our Mechanized Cavalry Brigade marched 700 miles over hilly and blistering-hot Southern roads in four days. Eighty-six combat cars started the march, and 86 finished it under their own power.

The M2A3, built at the Rock Island Arsenal, was the first modern fighting vehicle issued to the Army. The more heavily armored M2A4, produced in quantity by the American Car and Foundry Company, soon superseded it as the standard tank of its class. The much-improved M-3 light tank, armed with a 37-mm. gun and machine guns—now being built in large numbers—is its direct descendant.

In 1938 Congress authorized the building of 18 medium tanks—enough to equip an entire tank company! The Ordnance Department was ready with plans and specifications for the 18-ton, 32-miles-per-hour Medium M-2, armed with a 37-mm. gun. From it were developed the M2A1's, a number of which were issued to troops in 1940. Reports from American observers at the Battle of France emphasized the need for more heavily armed tanks. When Congress appropriated funds for the building of what then seemed a large number of medium tanks, it was decided to design a new model with a 75-mm. gun in a side turret in addition to the 37-mm. in the upper turret. Because of the experience gained during the long development period, designing the Medium M-3 took only a few months and early in the spring of 1941 production was started by the American Locomotive and Baldwin Locomotive companies and the Chrysler Corporation.

In the African battles before our invasion the M-3 proved itself to be by far the best tank on the desert. But that didn't satisfy our Ordnance tank experts. They wanted to give our Armored Force an even better medium tank, and they did it by designing the Medium M-4.

(Continued on page 240)

Milling Machines

Under engineering development for two years, this compact Milling Machine was ready for active work when Uncle Sam's industry began tooling up for planes, guns, ships, and tanks. It handles the complete range of milling — from slabbing and facing cuts to end milling, keyways, finishing and layout work. Operates from 1/3 HP 1740 RPM motor. Precision ground table is 4½" x 18".

Shapers

These are great time and money savers in the victory program. They relieve larger machines of all work within a 7" stroke. Work set ups are faster, cost is low, motor required is but 1/2 HP. Features include crank type bull gear drive, 4 speeds, 5 automatic cross feeds, complete V belt drive. Atlas Shapers are steady reliable producers in key war plants and serve important military units.

ASK the men of the army and navy maintenance forces . . . ask the men on America's fastest production lines . . . they'll tell you a most familiar trademark today is "ATLAS." They see it on Atlas Lathes, Drill Presses, Milling Machines, and Shapers. They see it everywhere behind the lines because Atlas Tools are in great demand and Atlas production has won the coveted Army-Navy "E" Award. As a potential Atlas buyer you can be glad Atlas is producing "fighting tools." It means the Atlas equipment you want after the war is proving its precision and rugged strength in the toughest test of the ages. Atlas Press Co., 355 N. Pitcher St., Kalamazoo, Mich.

VICTORY FIRST! - THEN Atlas TOOLS FOR YOU

Why Our Tanks Are Best

(Continued from page 218)

Captured German, Italian, and Japanese tanks have been subjected to every conceivable practical and engineering test by our Ordnance officers. These tests have confirmed the strong battlefield evidence that they aren't nearly as good as ours.

One of the reasons is that, type for type, ours have thicker and better armor than those of our enemies. The German light tanks, with armor only 7/10 inch thick, give the crews so little protection that they no longer are used for serious combat. The Nazi designers made the same fatal mistake with their Mark IV medium tank. Its original 1½-inch-thick body armor has been strengthened at especially vulnerable spots by bolting one-inch-thick plates over it, but these reinforcements aren't nearly so strong as solid plates would be.

The exceptionally high quality of American tank armor is the result of many years of experimental and development work in Government arsenals. Rolled face-hardened plate, which keeps out the bullets of high-powered machine guns, is used on light vehicles. Rolled homogeneous plate, which absorbs the terrific shock of large-caliber projectiles and also affords sure protection against machine-gun fire, is used on some of our heavier tanks. Tank plates now are welded together instead of being riveted. The use of cast armor is increasing. It can be cast into curved and sloping plates which deflect many projectiles. Our new M-4 medium tank has a cast-armor body.

Another, and very important, reason for our tanks' superiority is that, ton for ton, their light and compact airplane-type radial air-cooled engines are about twice as powerful as the engines of most European-built tanks. The ratio of engine power to vehicle weight of World War I tanks was about six horsepower per ton; in our modern tanks it is about 18 horsepower per ton. This high power-to-weight ratio makes them faster than opposing tanks and enables them to maintain speeds of from 10 to 20 miles per hour in sand or mud and on steep slopes and over obstacles. Speed is almost as good protection as armor—the faster a tank moves the fewer shots hostile tanks and antitank guns can get at it after it comes within their effective range.

Synchro-mesh transmissions now are used on most of our tanks, but several types of electrical and hydraulic variable-speed transmissions are being developed. Future use of one of them would eliminate the clutch. Our controlled-differential steering

system is better than the steering system used on any foreign tank. The articulating-bogie suspension—the development of one of Christie's many tank inventions—is both simple and reliable, and its efficiency in cushioning road shocks is higher than that of other systems. Our rubber-block tracks are beyond argument the world's best. Other armies' tank tracks may last for a few hundred miles; ours last for thousands.

The medium tank has become the most important weapon of mechanized ground warfare—both the spearhead and the shield of armored might. When our Armored Force was organized in the summer of 1940, it had twice as many light as medium tanks; now the proportion is three mediums to two lights.

Our new standard medium tank, the M-4, now rolling off the production lines of a half dozen immense plants, is being built in two models. One has a cast-steel hull and turret; the other an all-welded hull and a cast-steel turret. Its weight is about the same as that of the M-3, but since it is built closer to the ground it is a more difficult target, and its contoured armor is hard to hit squarely enough to penetrate.

Our new 15-ton light tank, heavily armored for its weight, fast, and armed with a 37-millimeter high-velocity gun mounted in a revolving turret, seems definitely superior to Axis tanks of its class.

Heaviest of our tanks is the 57-ton model. It has a welded body and cast-steel armor, and a steel apron to protect its tread mechanism. Its armament consists of a high-velocity gun of immense power and a 37-mm. gun mounted in a heavy revolving turret, and a number of machine guns. It is remarkably fast for its immense weight, and so well designed that it is easily maneuverable

In building tanks with which to equip their panzer divisions the Nazis concentrated on quantity rather than on quality. They won the early armored battles of the war not because they had better tanks than the British and French, but because they had many more of them at the important spots and because they handled them much better. The tanks they are using today were designed in 1936, and there have been almost no improvements in them since the beginning of the war.

All of our tanks now in production, although their mechanical features are the result of years of steady development, have been designed from the lessons of large-scale mechanized warfare. Our Army Ordnance tank experts are confident that they are the best tanks in the world, but they will keep on trying to make them better until we have won the war.

Typical American Flyer

(Continued from page 101)

ment of a featherweight plastic sun helmet, with a patent suspension that made one size fit almost any man's head. Moreover, he had specialized for the last year in efforts to design a satisfactory oxygen mask from molded plastic. He knew the problem, and would tackle it enthusiastically. He was called on the telephone and told that he was selected to make the heads, and make them quick.

Lieutenant Randall hurried to Chicago with his figures. In 16 working hours, with Randall checking the measurements and supplying anatomical criticism, Head I was completed. In a little more than two weeks, working with fanatical zeal, they had completed not five but seven heads. These weren't art, but they were designers' data of the utmost importance. Cast in plaster by technicians at the Field Museum, they were in immediate demand. Sets were supplied not only to all oxygen-mask designers but also to the Navy, the Armored Force, the Chemical Warfare Service, the R.A.F., and the air forces of Canada, Australia, and South Africa.

These plaster heads will be useful in the designing of all kinds of aviators' headgear —masks, goggles, helmets, or even a one-unit combination of all three. But the crucial point at this time is the fitting of the mask, and in this the most important measurement is what is called the nasion-menton dimension: that is the dimension from the root of the nose to the tip of the chin. The bony structure of these two parts makes it necessary to get a relatively close fit in order to make a leakproof mask. Over the cheeks there is more leeway, taken up by the flexibility of mask and flesh.

In the 1,871 men measured, the nasion-menton varied from a maximum of 145 millimeters to a minimum of 102 millimeters, giving a span of 43 millimeters to be fitted by as few different sizes as possible. But three quarters of the individuals measured—1,453—had nasion-mentons of 122, 123, or 124 millimeters. Head I, the grand mean, has this dimension at 123 millimeters; and the mask which fits him will be a pretty good fit on the great majority of the men concerned.

Heads II and III present an optical illusion. Though they don't look like it, they have the same nasion-menton as Head I. But Head II, the hatchet-faced boy, is a composite of the minimum values (that is, the smallest measurements) found in the

(Continued on page 224)

Typical American Flyer

(Continued from page 223)

1,453 individuals in the 122, 123, and 124-millimeter group. Head III, the one which looks like a Roman emperor or a big Slav, is composed of the biggest measurements found in the same group. These two will be important when it comes to fitting helmets, hat size varying from 6⅝ to 7⅝.

From the mask standpoint, Heads IV and V are next in importance to Head I. They represent, respectively, the average values found in the lower 15 millimeter of nasion-menton dimensions and those found in the upper 16 millimeter. They represent only a relatively small number of flyers, but include the longer and shorter thirds of the measurement scale. It is possible that a practical mask may be made in just these three sizes.

Heads VI and VII are the out-sizes. Each is a composite of the 16 faces falling in top and bottom measurements. Roughly, they are the long and short one percent.

These heads are only a beginning in what Randall and Borkland see as the new art of "human engineering." Today they are working in a new frenzy, developing means of properly jointing and reproducing three models they have made of composite body sizes of the same 1,871 flyers. These may have great importance, as warplanes attain still greater refinements of space-saving.

For instance, how large should a turret be in a bomber? Every ounce of weight is precious. If turrets were built with gunners as models, that might lead to great error and disaster. For it seems that gunners are smaller than flying cadets. But if a gunner is put out of action, it may well fall upon the navigator, bombardier, or copilot to take over the gun.

When pursuit planes dive at 725 miles an hour, the limit of a pilot's physical abilities are very nearly reached. No detail which may increase the flyer's comfort or contribute in any way to his efficiency can be overlooked. Up to now cockpits have been built in accord with general notions of the size and proportions of the men who use them. With the Randall-Borkland figures as guides, it will be possible not only to have mass production of planes, but also to have their fittings practically tailor-made for the pilot.

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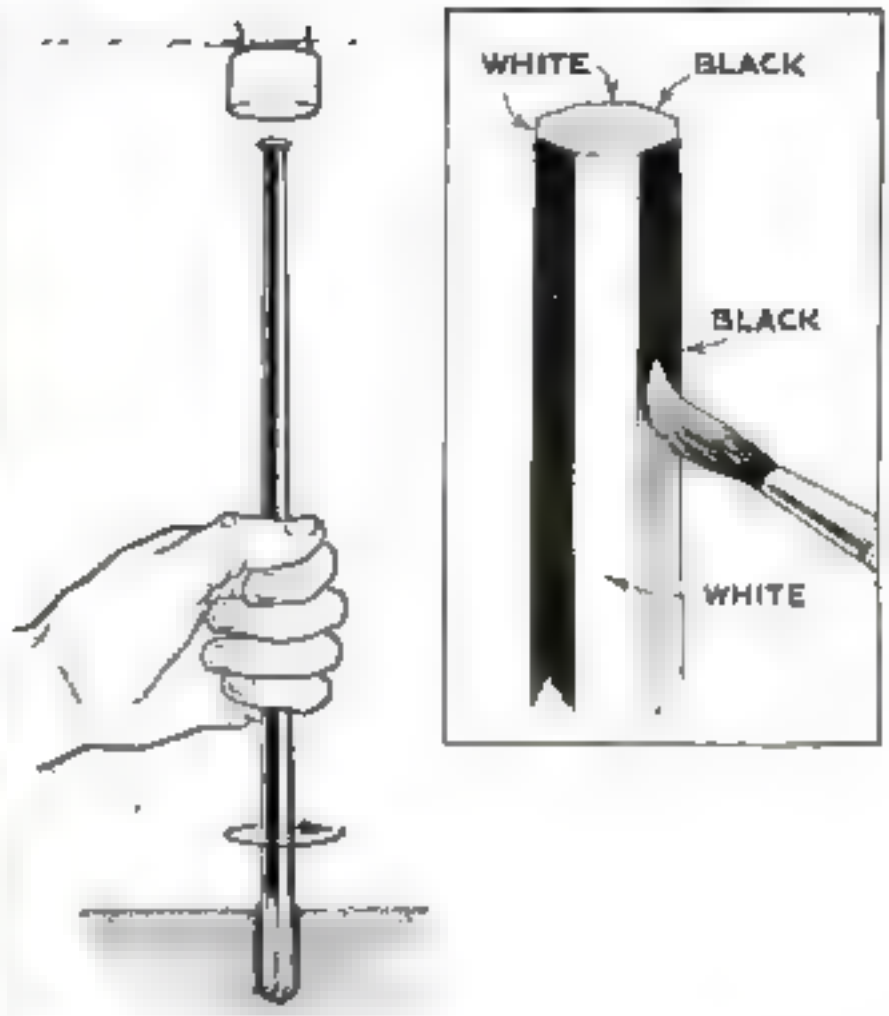
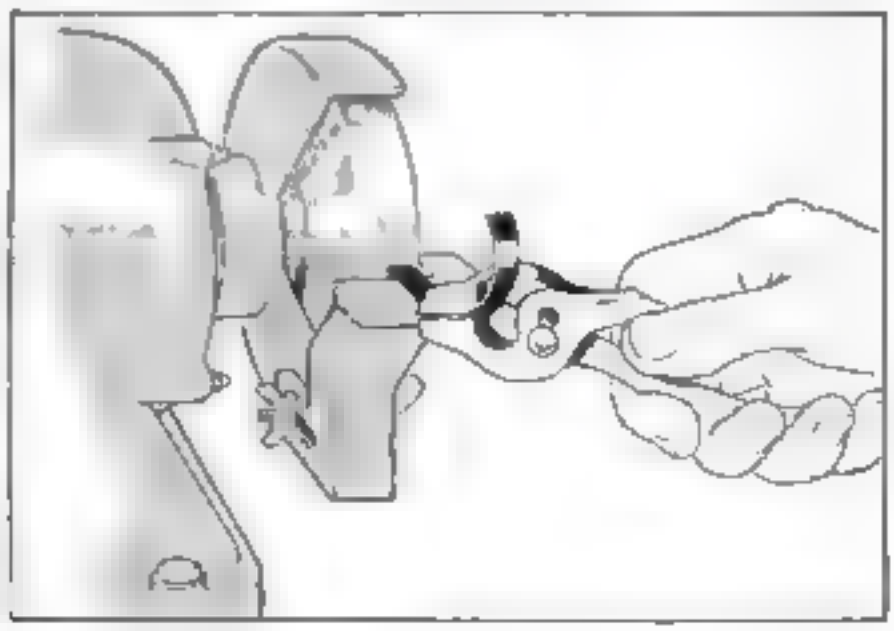


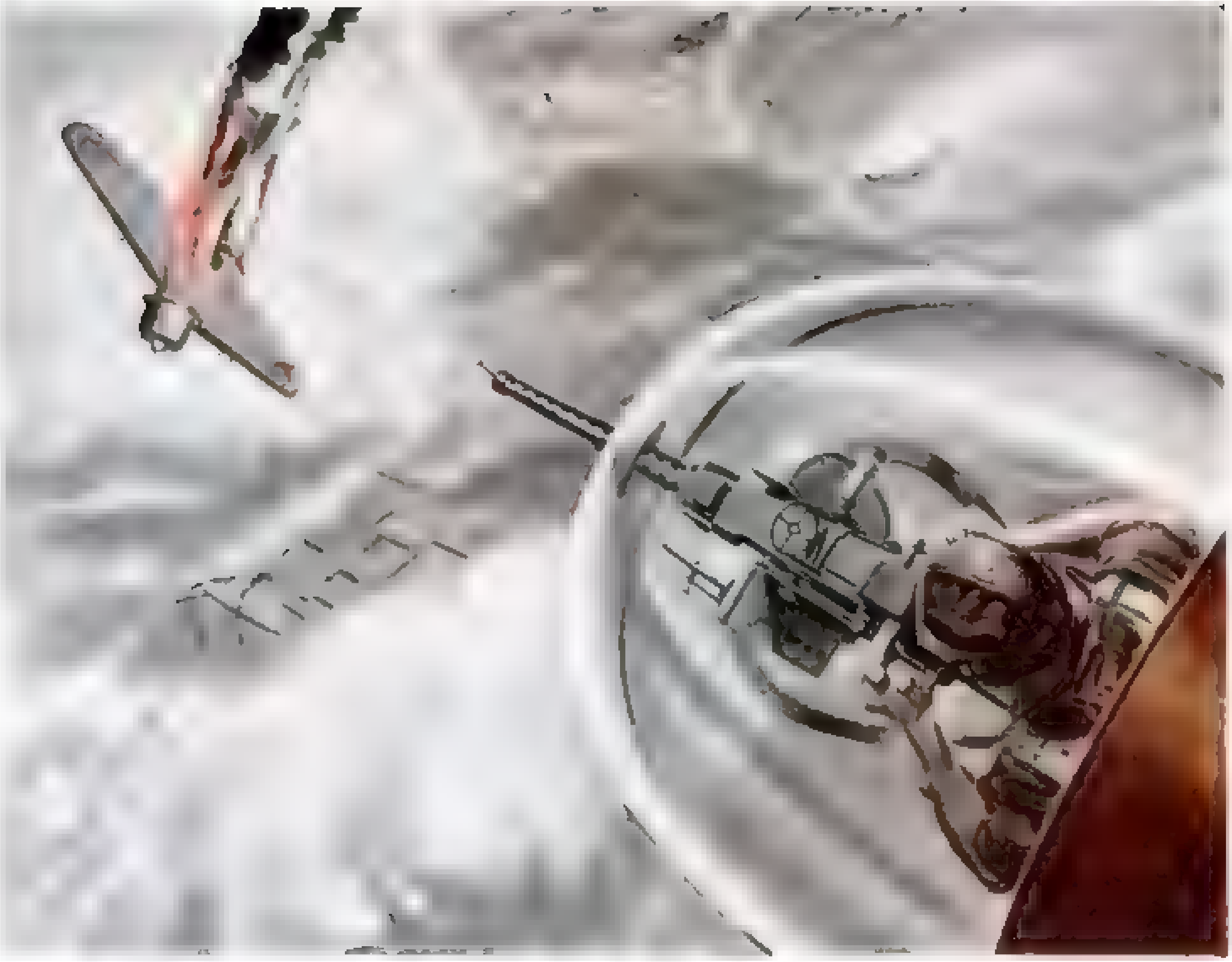
Striped Shank for Star Drill

AN EASY way to insure giving star drills the proper amount of rotation with each hammer blow, in order to produce the maximum depth of cut, is to paint the shank with alternate vertical stripes of black and white. This will provide a means of telling how much the drill is turned each time. Although the one shown is of octagonal stock, round ones may be marked in the same way.—J. MODROCH.

Old Spring Dresses Grinder

PIECES of an old phonograph or clock spring cut about 6" long are useful for dressing grinding wheels. Hold such a piece about 1" or less from its tip in a pair of pliers and place it against the revolving wheel, making sure your eyes are adequately protected. This will produce a fine chatter which will sharpen your grinding wheel and dress it perfectly round.—J. P. DIRKS.





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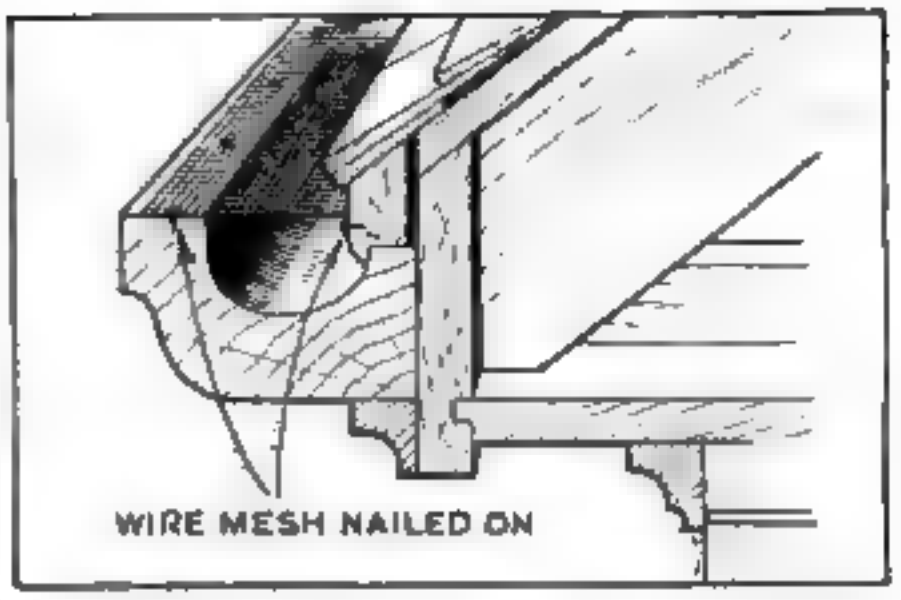


Mesh Keeps Roof Gutters Clear

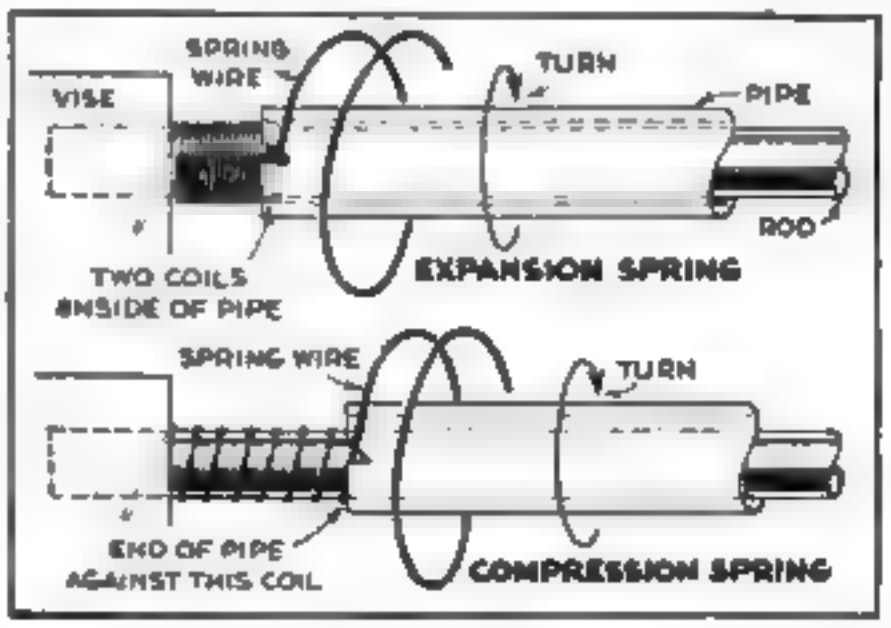
WHERE a house is surrounded by large trees, the gutters and leaders are likely to become clogged with wind-blown leaves. This difficulty can be overcome by covering the gutter with ¼" galvanized wire mesh.

If the gutter is of the metal type, cut the mesh into strips ½" wider than the distance from the outer top edge of the gutter to the cornice board and turn the extra ½" to form a right-angle lip. Nail this lip to the wood cornice and snap the other edge into the ridge at the top of the gutter. The wind will keep the top of the screening clear of leaves. Attach wire mesh to wooden gutters as shown above.—ARTHUR H. MARTINI

Making Springs by Hand

COMPRESSION and expansion springs can be wound on a rod with the help of a notched pipe having an inside diameter the size of the spring to be made. Clamp the end of a length of piano wire with the rod in a vise so that the wire is held at an upward angle. Saw a V-shaped notch in the end of the pipe, with one side parallel to the pipe axis. This should be the rear side of the notch as the pipe is turned.

Engage the wire in the notch, and turn it with the pipe, keeping the pressure uniform throughout. For a compression spring, space the wire; for an expansion type, hold the turns together.—A. H. VON DER OHE.



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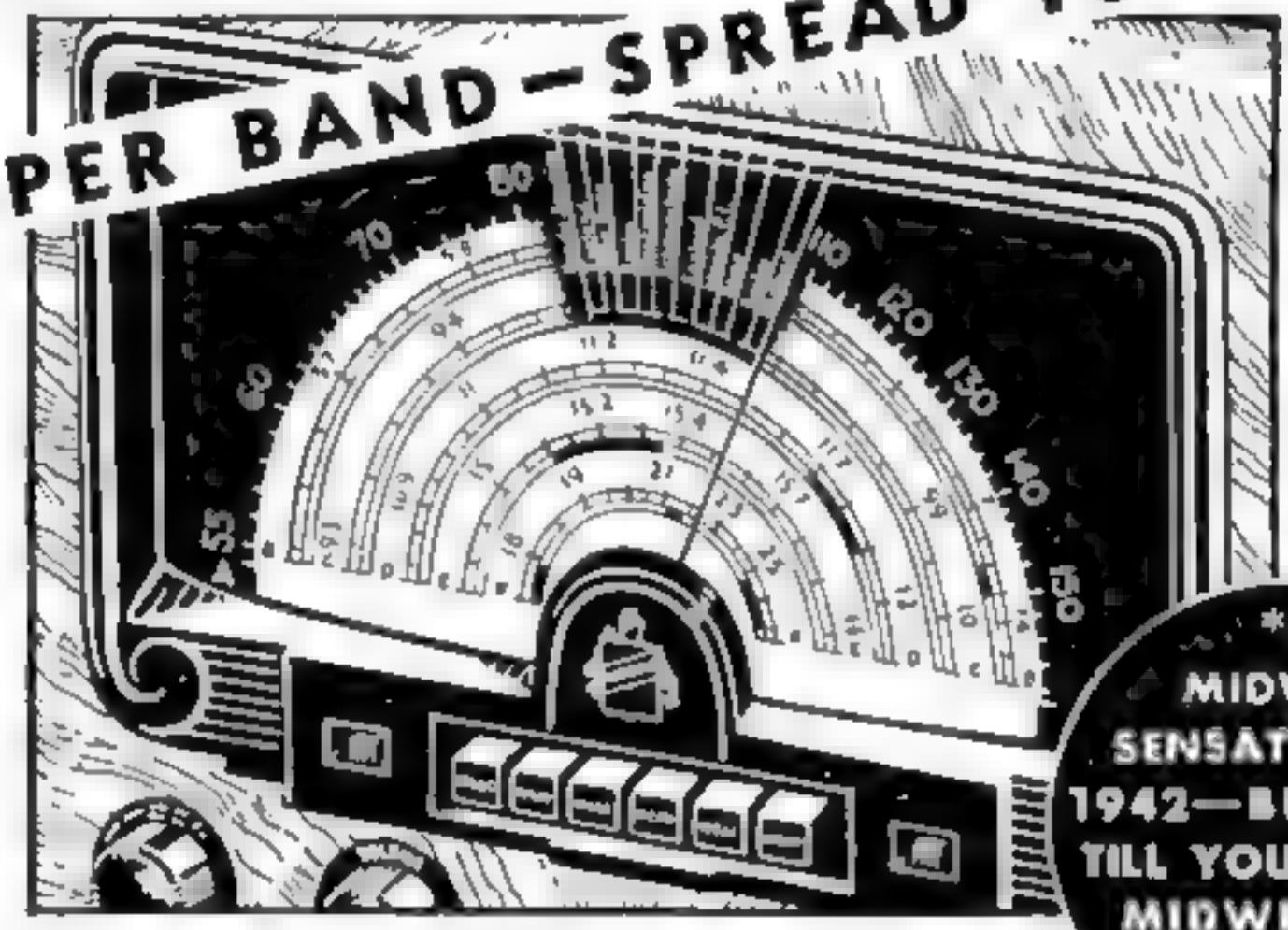

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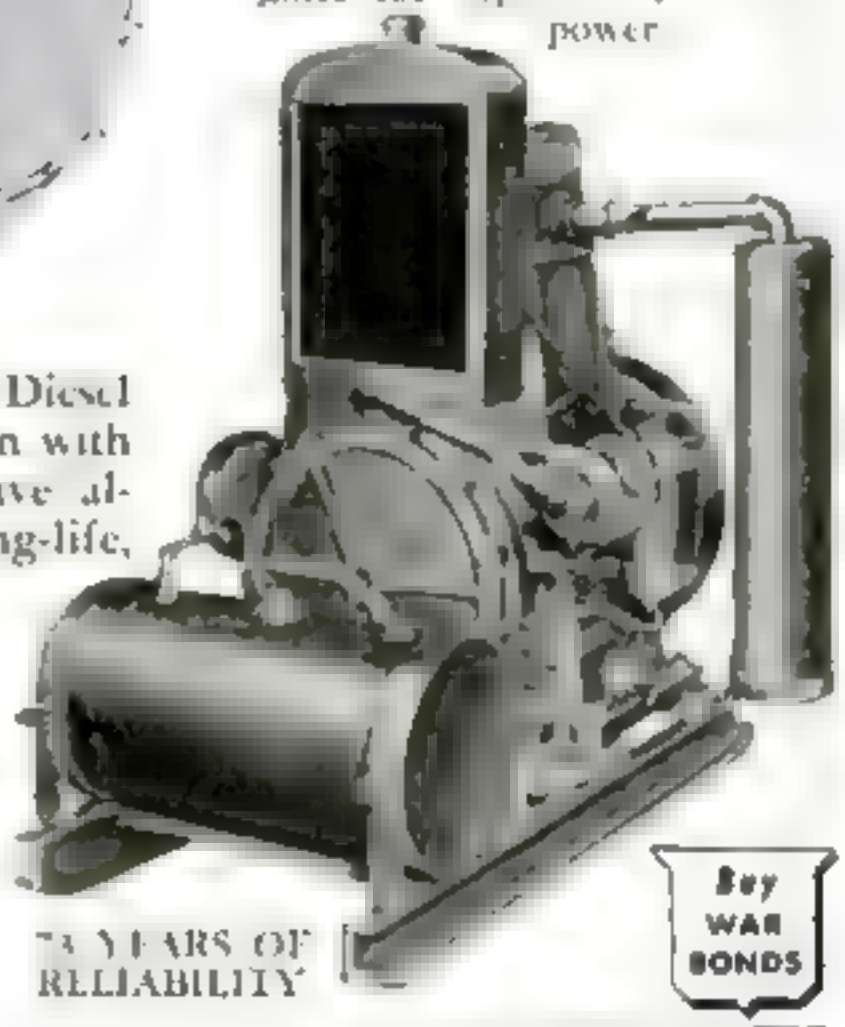

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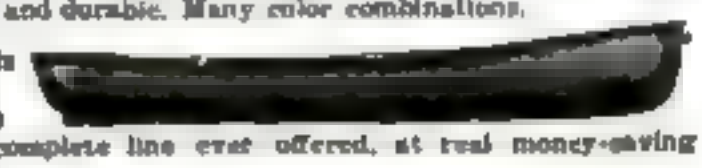

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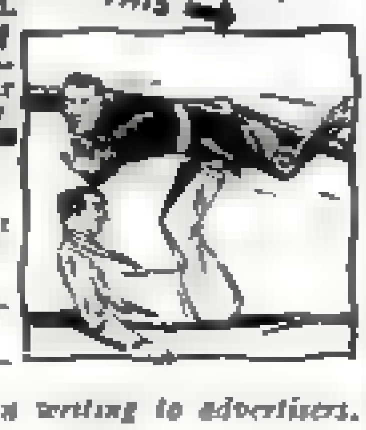

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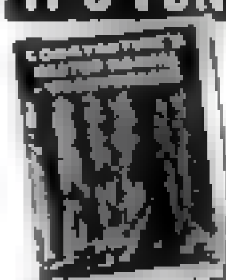

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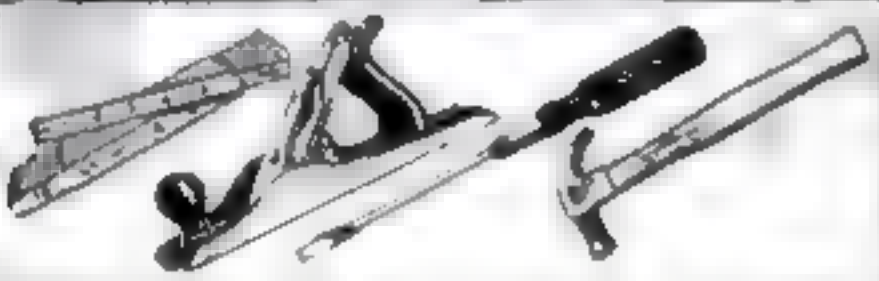

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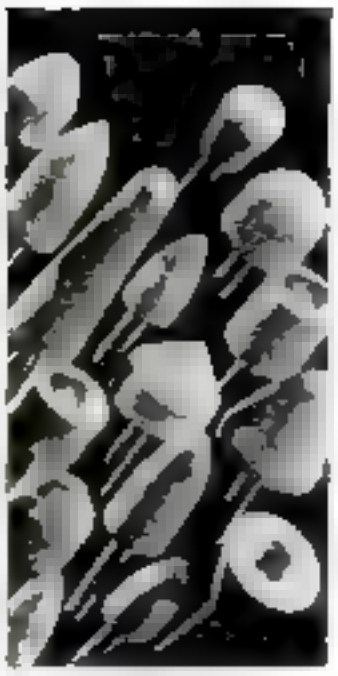

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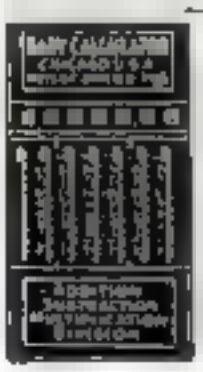

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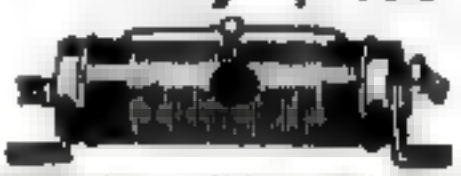

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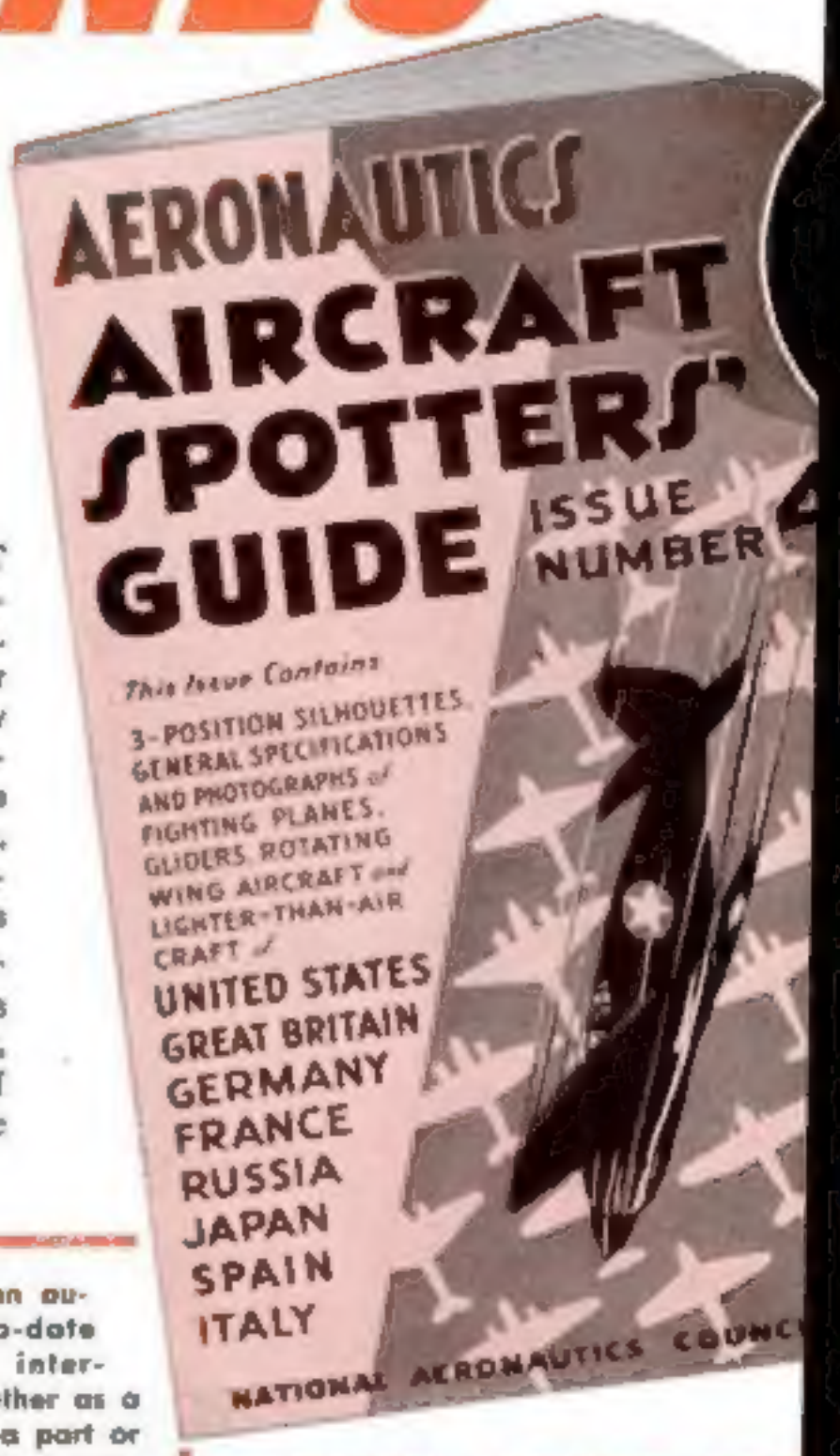

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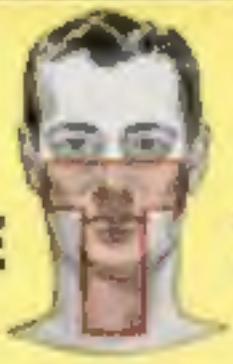

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